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THE

# AMERICAN JOURNAL OF SCIENCE

[FOURTH SERIES.]

## ART. XXXIII.—*On the Rate of Condensation in the Steam Jet;* by A. DEFOREST PALMER, JR., Ph.D. With Plate IV.

DURING his investigation on "The Condensation of Atmospheric Moisture," Prof. Barus,* while working with a steam jet, observed that the region of condensed vapor terminated below in a surface similar to that surrounding the inner part of a Bunsen flame. Its lower limit was parallel to the plane of the nozzle and at a distance above it depending on the actuating pressure of the jet. At this surface the velocity of condensation downward is equal to the upward velocity of the steam, and this in turn is an inverse function of the distance from the origin. From a few preliminary measurements he was led to the opinion that the condensation velocity increased very rapidly with the pressure, and at his suggestion I have undertaken a further investigation of the subject by a photographic method similar to that employed by W. Michelson† in his study of the combustion velocity of explosive gas mixtures.

The calculation of the absolute velocity of condensation at any instant involves a knowledge of the specific volume of the steam and the curvature at every point of the surface of separation between the regions of condensed and non-condensed vapor. It is, however, probable that these two quantities are so related that the normal velocity is constant over the entire surface and hence may be expressed by the simple formula

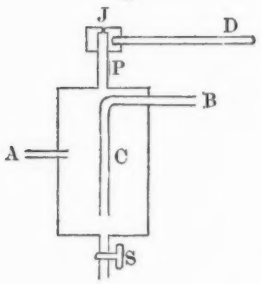
$$U = \frac{vm}{S}$$

* Bulletin No. 12, U. S. Department of Agriculture, Weather Bureau, 1895, p. 87.

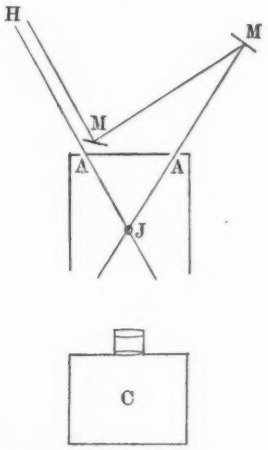
† Wied. Ann, vol. xxxvi, p. 1, 1889.

where U is the velocity, $v$ the mean specific volume at the surface, $m$ the mass of steam issuing from the nozzle in unit time, and S the area of the surface; $m$ and $v$ are obviously complementary functions of the actuating pressure P of the jet, and the effect of their product on the variations of U with respect to P may be neglected in making the approximate determinations which alone are possible at the present time. For the calculation of S and its dependence on P a series of photographs of the jet were made and estimations attempted from measurements of the negatives, but it was found impossible to produce images having sufficient detail throughout to permit of accuracy by this method. However, the distance D from the plane of the nozzle to the lower limit of the surface could always be quite accurately determined, and, as this quantity varies directly with S and hence inversely with U, its values for different values of P serve as an index to the changes in U. Hence, while it is impossible to determine the absolute condensation velocity under any given conditions, a general idea of the nature of its variations may be obtained from a series of measurements of the distance D.

1.




2.




A brass compressed air tank of about three gallons capacity, heated by a large Fletcher burner and fitted with a Bourdon gauge reading from zero to thirty pounds pressure, was utilized as a boiler and connected by quarter-inch gas pipe to the drying apparatus illustrated in fig. 1. Here C is a chamber about three inches in diameter by eight inches high, made of steam pipe and connected at A with an open tube mercury manom-

eter by which the actuating pressure of the jet could be determined. A globe valve in the pipe B, through which steam is admitted, serves to regulate this pressure, and the stopcock S allows the water condensed in the chamber to be drawn off from time to time. The whole apparatus is inclosed in a wooden box and the free spaces filled with hair-packing to prevent radiation. The nozzle, situated above C and connected with it by a short eighth-inch gas pipe bored smooth on the inside to prevent condensation on its surface, was in the first construction simply a brass block screwed to the pipe P and having a hole at J about two millimeters in diameter for the formation of the jet. With this arrangement it was impossible at moderately high pressures to prevent spitting of the jet caused by particles of moisture condensing within the nozzle and being driven out by the rush of steam in such a manner as to entirely mask the ordinary aspect of the jet and render accurate measurement impossible. This difficulty was entirely overcome by screwing a brass rod D to the side of the brass block and heating its outer end in a Bunsen flame to such a degree that the heat conducted to the nozzle was just sufficient to prevent condensation on its inside walls. Ordinarily a jet formed under these conditions is quite invisible unless viewed against a black background, but if it be placed in a beam of direct sunlight and viewed from a point just outside that beam it appears very brilliant.

Satisfactory photographs of the jet, by reasonably short exposures, can be made only when it is very strongly illuminated by direct sunlight and the camera is placed as near as possible to the line of this light without allowing it to enter the lens. The arrangement of the apparatus to accomplish this end is illustrated in the diagram fig. 2. The jet, J, is situated in a three-sided black box having windows at AA about one inch wide and three inches high. Part of a beam of sunlight from a heliostat beyond H passes directly through J, while a second part, after reflection at the small mirrors MM, passes through J at an equal angle on the opposite side. The camera C is placed midway between these two beams and at a distance from J such that neither of them enters its lens. The back of the camera is provided with a stop having an aperture in its center one and one-half by two and one-half inches, and the plate holder is arranged to slide behind this in such a manner that ten images can be made on a five by eight plate. A rotating shutter attached to the lens and actuated by a weight is so regulated by a spring on its axis that the length of exposure can be varied within sufficiently wide limits. With this arrangement exposures of from one-tenth to one-half a second gave very satisfactory results, and the scale of the images was determined by photographing a millimeter scale so placed that

its plane contained the vertical axis of the jet and was perpendicular to that of the camera.

Fig. 3 (Plate IV) is a reproduction of one of the series of photographs, and though quite inferior to the negative in point of definition and detail, gives a very good idea of the general form of the jet. The values of P in centimeters of mercury and of D in millimeters, corresponding to this series, are given in the following table, the numbers being taken from left to right.

| No. | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|---|
| P | 43·8 | 42·3 | 40·8 | 37·8 | 35·3 | 30·3 | 19·6 | 36·8 | 28·3 | 13·8 |
| D | 6·0 | 6·0 | 6·7 | 7·1 | 7·1 | 7·3 | 9·1 | 7·7 | 7·4 | 7·1 |

Fifty series of ten exposures each were made and the distances D corresponding to values of P up to about sixty-five centimeters of mercury very carefully measured on the negatives. Above this point the lower limit of condensation was always in coincidence with, or possibly below, the plane of the nozzle, showing that at very high pressures the condensation phenomena take place entirely within the nozzle. The result of these observations is shown graphically on the chart fig. 4, the abscissas being values of P to the scale one-half and the ordinates values of D to the same scale. All the points here represented have very nearly equal weight, and though errors of a few tenths of a millimeter might easily be made in the determination of D, the large variations in this quantity corresponding to the same pressure cannot be accounted for by errors of observation. Neither can they be explained by variations in the temperature and dust content of the air surrounding the jet, since the greatest change in this temperature during all the series of observations did not exceed two or three degrees centigrade as indicated on a mercury thermometer placed near the jet, and since many of the largest variations correspond to exposures the interval between which did not exceed a few seconds.

These considerations, together with the appearance of the image of the jet on the ground glass of the camera, led me to the opinion that the rate of condensation varied periodically, and hence that D, for moderate pressures at least, was a periodic function of the time. For the further study of this point I constructed a shutter having an electrical connection with the laboratory clock such that exposures of about one-tenth second could be repeated at intervals of one second. The actuating pressure being kept constant, a series of some thirty such exposures were made on the same plate and the distances D corresponding to each carefully determined. Eight such series of observations were made corresponding to different values of the pressure and the result of one of these is represented in fig. 5,

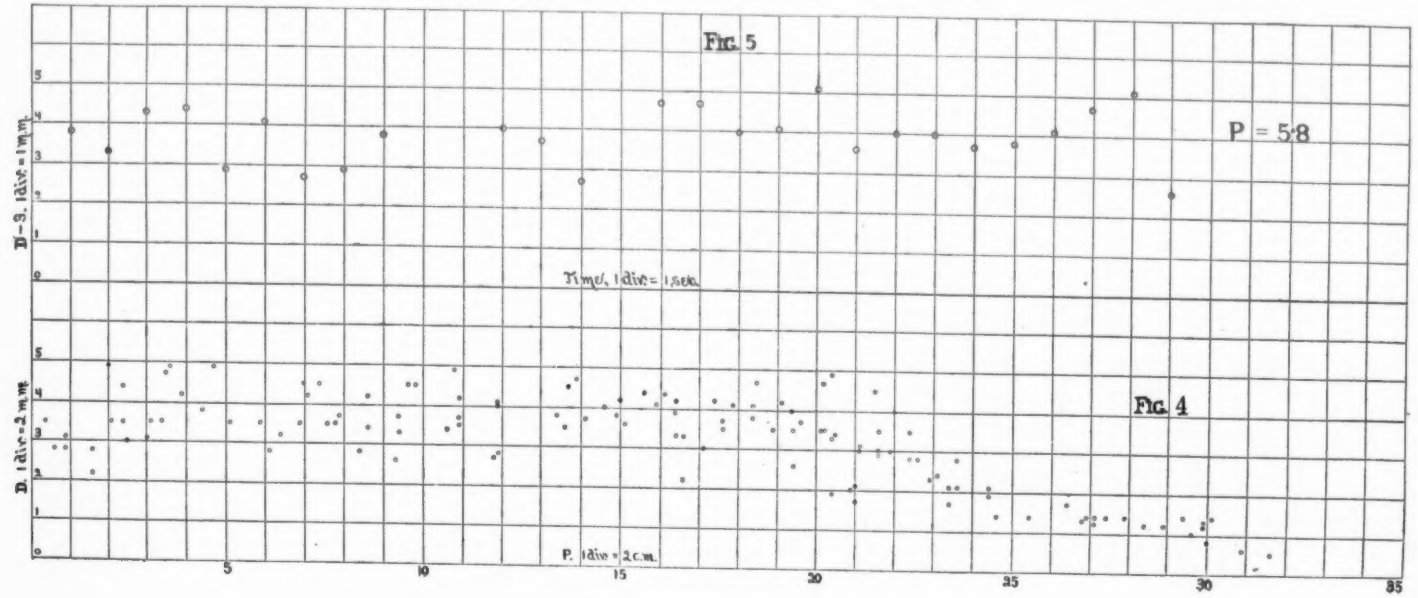


Fig. 5
P = 5·8
Time, 1 div = 1 sec.
D-3, 1 div = 1 m.m.
D, 1 div = 2 m.m.
P, 1 div = 2 c.m.
5
10
15
20
25
30
35

Fig. 4

where the abscissas are times in seconds and the ordinates values of D–3 in millimeters, the pressure being 5·8$^{cm}$ and the temperature of the surrounding air 25·5° C. The other series gave very similar results, and, while the time of exposure was too great to allow an accurate determination of the period in any case, the periodic nature of the phenomenon is established beyond doubt. If a series of photographs could be made by extremely short exposures rapidly following one another, it would probably be possible to accurately determine the amplitude and period of the function connecting D with the time, and hence also the dependence of these quantities on the actuating pressure of the jet. An attempt was made to accomplish this by utilizing the rapid discharges of a large Leyden jar battery as a means of illumination, but in no case was the light sufficient to produce measurable negatives.

Provided the temperature and dust content of the surrounding air remain constant, the velocities $V_1$ of the ascending vapor at any point of the jet and $V_2$ of the descending condensation may be expressed by the formulæ

$$V_1 = f_1(H, P)$$

and

$$V_2 = f_2(D, P)$$

where H indicates height above the nozzle and the other letters retain the meaning already ascribed to them. If

$$H = D = \text{Constant}$$

and if P is constant it is obvious that $V_1 = V_2$, but if

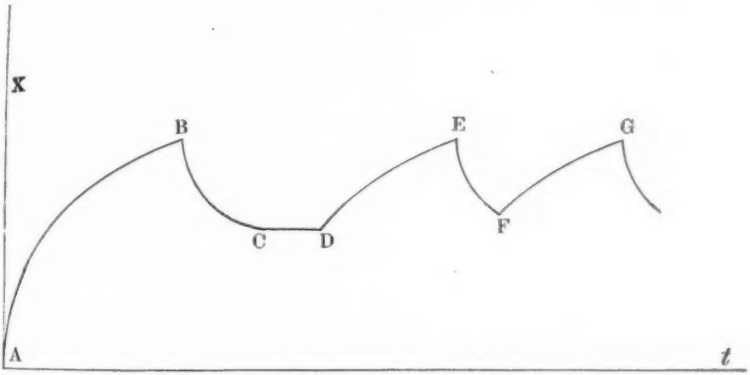
$$H = D = x$$

$V_2$ will be greater or less than $V_1$ according as $x$ is a decreasing or an increasing quantity.

The foregoing observations indicate that, the pressure being constant, $x$ is a periodic but not a simple harmonic function of the time, and it is possible that the phenomena may be graphically represented as in fig. 6, where the abscissas indicate time and the ordinates values of $x$. At the origin $V_2$ is zero. The steam, issuing from the nozzle, ascends with a gradually decreasing velocity and increasing degree of supersaturation until condensation commences, either spontaneously or induced by the entrance of dust particles from the surrounding air. The curve AB is thus traced, the velocity $V_2$ at each point being equal to $\delta x/\delta t$ and represented by the tangent to the curve. Beyond B the velocity which determines the value of $x$ is obviously the resultant of $V_1$ and $V_2$. At first $V_2$ is very much the greater, and the representative point rapidly descends along some such curve as BC. During this operation the suc-

cessive positions of the limit of condensation correspond to constantly increasing values of the velocity $V_1$ and a point C is finally reached at which $V_2$ is equal to $V_1$ and the curve becomes an horizontal straight line. This character is maintained until, for some unknown reason, condensation entirely ceases at D and the original phenomenon repeats itself, producing the curve DE identical with the upper part of AB. At E condensation again takes place and the representative point moves along the line EF in all respects similar to BC. It is quite possible that, as indicated at F, the cessation of condensation may take place before the point at which $V_2 = V_1$ is reached, but however this may be, the curves lying between two successive beginnings of condensation should be repeated so long as the conditions remain the same. The figure shows two possible forms, B C D E and E F G, but does not assume to represent an actual case, which would probably consist of an indefinite repetition of the same form.

6.




Obviously $V_2$ can never be less than the value of $V_1$ corresponding to the lowest points of the curve, and if a definite horizontal portion could be determined from the observations its height above the axis would give the absolute value of the velocity of condensation under the given conditions. The observations above recorded, probably on account of the relatively large interval between them, give no definite evidence of this portion of the curve, but an attempt was made to determine a lower limit for $V_2$ by the calculation of $V_1$ for the lowest observed points corresponding to the same pressure. It was, however, found impossible to accomplish this, with more than a very rough degree of approximation, on account of the

lack of data regarding the distribution of pressure and specific volume throughout the jet, and I have, therefore, reserved this part of the work until measurements of these quantities can be made.

Turning now to the effect of the actuating pressure, it is obvious that both

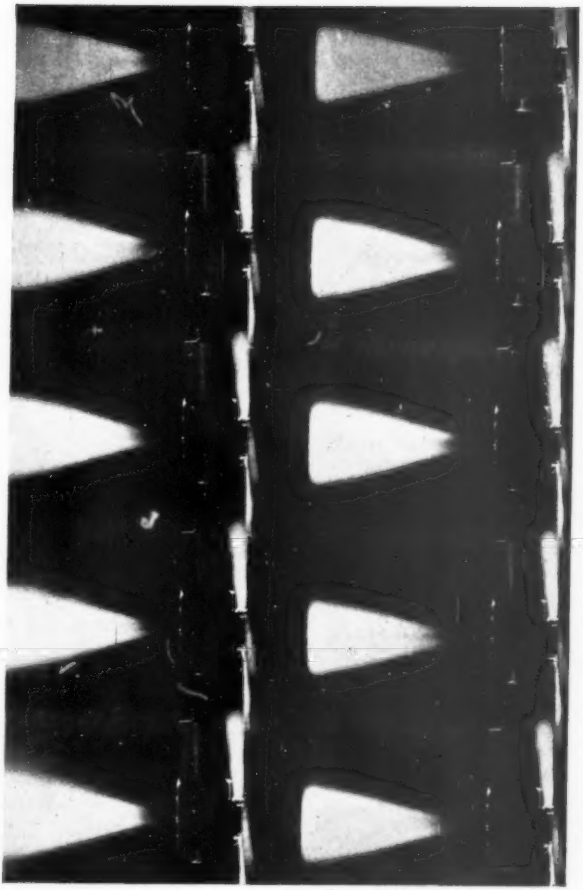
$$V_1 = f_1(H, P) \text{ and } V_2 = f_2(D, P)$$

increase with P. If $f_1$ and $f_2$ increase at the same rate, the lowest points of the curves, similar to those of fig. 6, corresponding to different pressures will be all on the same level. If $f_1$ increases faster than $f_2$ the height of these points will increase with the pressure. Finally if $f_2$ increases faster than $f_1$ this height will decrease. The observations plotted in fig. 4 leave no doubt that the latter supposition is correct, and hence the velocity of condensation must increase in marked degree with the pressure. Furthermore since the initial velocity of the jet and the rate of decrease of $V_1$ from the nozzle upward increase with the pressure, it is to be expected that the amplitude of the oscillations will decrease, and this expectation is amply born out by the observations.

Regarding the abrupt cessation of condensation, as at D and F, fig. 6, Prof. Barus has suggested that it is possible that the heat of instantaneous condensation may be sufficient to superheat the advancing steam and thus destroy the supersaturation. In support of this view it may be remarked that the probable period of the oscillations is so short that very little heat escapes from the jet, and that, the latent heat of steam being 540 and its specific heat 0·5, sufficient heat is liberated by the condensation of one gram of steam to heat one gram of steam about 1000° C.

In concluding I wish to express my thanks to Prof. Barus for his kind suggestions and encouragement.

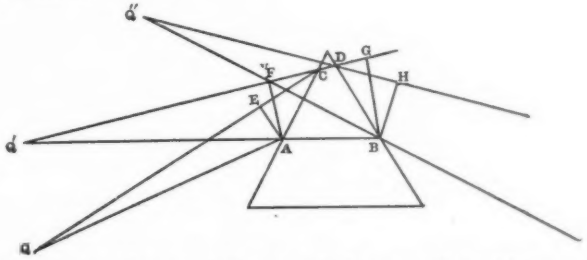
Wilson Physical Laboratory of Brown University, July 1, 1896.



Scale one-half.

ART. XXXIV.—*The Longitudinal Aberration of Prisms;* by CHARLES G. ABBOT and FREDERICK E. FOWLE, JR.

HAVING had occasion recently to consider the propriety of dispensing with collimation in the spectro-bolometric train at the Smithsonian Astrophysical Observatory, we have consulted with profit the equation given by Lord Rayleigh* for the longitudinal aberration of a prism in the case of a cone of rays incident with the central ray in minimum deviation. We have had occasion in doing so to develop formulæ slightly differing from those of Lord Rayleigh, and have thought it not without interest to present the results of a somewhat closer approximation. In the following demonstration we have employed, so far as possible, the same notation as Lord Rayleigh to facilitate comparison.




Let QA be the central ray of the pencil incident at the angle for minimum deviation. Let the angles of incidence and refraction of QA be $\phi$ and $\phi'$ respectively. Let QC be a second ray incident at the angle $(\phi+\delta\phi)$ and let the foci of the prism be Q′ and Q″. The angles AQ′C and BQ″D are $\delta\phi'$ and $\delta\phi''$ respectively. And let AE, AF, BG and BH be perpendicular to QC, Q′C, Q′G and Q″H respectively. Let $QA = u$, $Q'A = u'$, $Q''B = v$, $AB = l$. Powers of $\delta\phi$ higher than the first will be neglected.

$$AE = u\delta\phi \tag{1}$$

$$AC = \frac{AE}{\cos.(\phi+\delta\phi)} \tag{2}$$

$$AF = AC\cos(\phi'+\delta\phi') \tag{3}$$

$$u' = \frac{AF}{\delta\phi'} \tag{4}$$

$$BG = AF + l\delta\phi' \tag{5}$$

* Philosophical Magazine, V, ix, p. 44, 1880.

$$BD = \frac{BG}{\cos(\phi' - \delta\phi')} \tag{6}$$

$$BH = BD \cos(\phi - \delta\phi'') \tag{7}$$

$$v = \frac{BH}{\delta\phi''} \tag{8}$$

But $$\mu \sin.(\phi' + \delta\phi') = \sin.(\phi + \delta\phi) \tag{9}$$

whence $$\delta\phi' = \frac{1}{\mu} \cdot \frac{\cos\phi}{\cos\phi'} \delta\phi - \frac{1}{2\mu} \cdot \frac{\sin\phi}{\cos\phi'} \left(1 - \frac{\cos^2\phi}{\mu^2 \cos^2\phi'}\right) \delta\phi^2 \ldots \tag{10}$$

Similarly $$\mu \sin.(\phi' - \delta\phi') = \sin.(\phi - \delta\phi'') \tag{11}$$

whence $$\delta\phi'' = \delta\phi \tag{12}$$

Substituting these values, expanding and reducing we have,

$$v = u + \frac{e}{\mu} \cdot \frac{\cos^2\phi}{\cos^2\phi'} + \left\{ 2u\left(\tan.\phi - \frac{\tan\phi'}{\mu} \cdot \frac{\cos\phi}{\cos\phi'}\right) + \frac{l}{2\mu}\left(\frac{\sin\phi\cos\phi}{\cos^2\phi'} - \frac{\tan\phi' . \cos^3\phi}{\mu\cos^3\phi'}\right)\right\} \delta\phi . \tag{13}$$

and

$$\delta v = \left\{ 2u\left(\tan\phi - \frac{\tan\phi'}{\mu} \cdot \frac{\cos\phi}{\cos\phi'}\right) + \frac{l}{\mu}\left(\frac{\sin\phi . \cos\phi}{\cos^2\phi'} - \frac{\tan\phi'}{\mu} \cdot \frac{\cos^3\phi}{\cos^3\phi'}\right)\right\} \delta\phi . \tag{14}$$

For the rays incident at the angle $(\phi - \delta\phi)$ we must give $\delta\phi$ the negative sign in these expressions. Hence if $v_1$ and $v_2$ are the focal distances for the rays incident at the angles $(\phi + \delta\phi)$ and $(\phi - \delta\phi)$ respectively, we may express $v_1$ and $v_2$ as follows:

$$v_1 = u + Al + B\delta\phi + C\delta\phi^2 + D\delta\phi^3 + \ldots . \tag{15}$$

$$v_2 = u + Al - B\delta\phi + C\delta\phi^2 - D\delta\phi^3 + \ldots . \tag{16}$$

where A, B, C and D are factors independent of $\delta\phi$;

whence $$v_1 - v_2 = 2B\delta\phi + 2D\delta\phi^3 + \ldots \tag{17}$$

or, neglecting powers of $\delta\phi$ higher than the second, the total longitudinal aberration $\Delta v$ is

$$\Delta v = 2B\delta\phi \tag{18}$$

where $$B = 2u\left(\tan\phi - \frac{\tan\phi'}{\mu} \cdot \frac{\cos\phi}{\cos\phi'}\right) + \frac{l}{2\mu}\left(\frac{\sin\phi . \cos\phi}{\cos^2\phi'} - \frac{\tan\phi'}{\mu} \cdot \frac{\cos^3\phi}{\cos^3\phi'}\right) \tag{19}$$

For comparison with Lord Rayleigh's equation (19), we derive from equations (4), (3) and (6)

$$u' = \frac{\mathrm{FA}}{\delta\phi'} = u\,\frac{\delta\phi}{\delta\phi'}\cdot\frac{\cos(\phi'+\delta\phi')}{\cos(\phi+\delta\phi)} \qquad (20)$$

$$\mathrm{AC} = y = \frac{u\delta\phi}{\cos(\phi+\delta\phi)} = \frac{u'\delta\phi'}{\cos(\phi'+\delta\phi')} \qquad (21)$$

$$\mathrm{BD} = y' = \frac{\mathrm{AF}+l\delta\phi'}{\cos(\phi'-\delta\phi')} = \frac{(u'+l)\delta\phi'}{\cos(\phi'-\delta\phi')} \qquad (22)$$

whence $$\frac{y'}{y} = \frac{u'+l}{u'}(1-2\tan\phi'\,.\,\delta\phi' + \ldots\ldots) \qquad (23)$$

That the approximations made in equations (19), (24) and (25) of Lord Rayleigh's article may be of significance as materially affecting the value of $\delta v$, is shown by calculations made with the following data:

$u = 1000^{\mathrm{cm}}$, $\quad l = 6{\cdot}5^{\mathrm{cm}}$ $\quad \phi = 50^\circ\ 12'\ 20''$,
$y = 5{\cdot}5^{\mathrm{cm}}$ $\quad \delta\phi = 12'\ 3''$, $\quad \phi' = 30^\circ\ 0'\ 0''$, $\quad \mu = 1{\cdot}5367$

Lord Rayleigh's formula gives:

$$\delta v = 9{\cdot}7^{\mathrm{cm}}$$

The formula deduced above gives:

$$\delta v = 6{\cdot}5^{\mathrm{cm}}$$

Astrophysical Observatory, Smithsonian Institution, June 15, 1896.

## Art. XXXV.—*Abnormal Hickory Nuts;* by Francis Hobart Herrick. With Plate V.

There are preserved in the collections of the Kirtland Society of Natural Science, now incorporated with those of Adelbert College of Western Reserve University, two specimens of abnormal hickory nuts of a unique and singular character. They have never been described, but were always regarded with the greatest interest by the pioneer naturalist of the Western Reserve, the late Dr. Jared P. Kirtland. The nuts were kept in a glass case which bore a label neatly written by Dr. Kirtland, giving the only history of them which has been preserved.

This label reads as follows: "D. G. Streator, M.D., collected in autumn last (1875) a quart of these nuts, under a hickory tree, overspread by a larger black oak, in the town of Windham, Portage Co., Ohio. Externally they resembled hickory nuts, but internally each contained a perfectly formed acorn, stem, and excessively bitter meat, like the numerous acorns of the black oak."

"The specimens and foregoing facts were furnished me by T. Garlick, M.D. Both he and Dr. Streator are residents of Bedford, Cuyahoga Co., Ohio."

The persons mentioned by Dr. Kirtland are dead, and there is probably no one now alive who could throw any light from personal knowledge upon the statement just quoted.

It seemed to me that a careful analysis of the structure of these nuts might prove of interest. Accordingly I have studied their histological structure, and compared it with that of the normal hickory nut, and incidentally with that of the acorn.*

The general appearance of the two nuts is very similar from without, and when cracked open they show an inclosed acorn-like nut, as is well shown in the photograph (fig. 1, *a–e*, Plate V). The outer husk or exocarp is not preserved, so that nothing is known of its appearance. The endocarp or nut proper of the abnormal specimens consists of a thick and very dense outer shell, which is moulded upon a smaller inner nut. This inner nut resembles an acorn in form, and is attached to a distinct stem (fig. 1, *a*) which separates readily from the rest of the nut. The stem is fastened to the acorn-like body by an expanded cup-shaped end, which recalls the cupule of the oak. The wall is less dense over the area of attachment than in the other parts of the nut, forming a circular hilum which resembles that of an acorn. These facts are illustrated by fig. 1,

* I am much indebted to my colleague, Professor H. P. Cushing, for the skillful preparation of thin sections of all the nuts examined.

*a–c* and by the drawings of the profile and transverse sections of the normal and abnormal nuts (figs. 2, 3, 4, 5).

Figure 4 is a line drawing of fig. 1, *b*, and shows the profile of the nut, and one-half of the mould, so to speak, of the inner nut and its stem. In the transverse section of the normal hickory nut (*Carya sulcata*) the outline is generally oval and the two folded halves of the meat are seen (fig. 3). In the abnormal nut (fig. 5) the form of the endocarp at the outer surface is markedly hexagonal, while the dense shell of the inner nut appears as a ring (represented black to differentiate it) and within this are the compacted intertwined cotyledons of the meat.

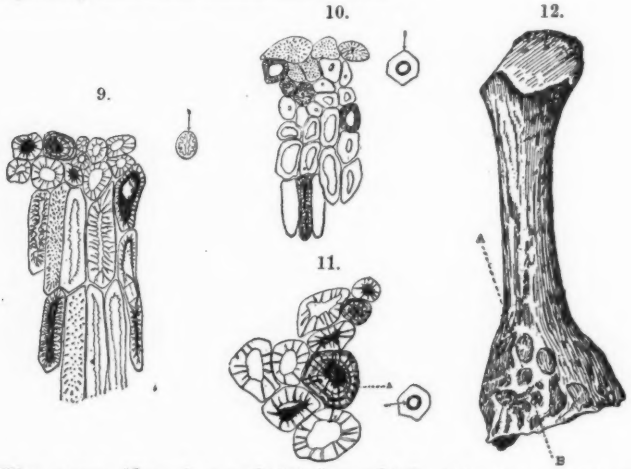
The meat of one of the nuts when removed (fig. 6), though preserved for twenty-one years, had not perceptibly shrunken. It was covered with a dark brown skin, and capped with a thin disk of tissue corresponding to the hilum of the stalk. There were slight longitudinal creases on its surface, and in transverse sections taken at different levels (figs. 7, 8) we see the complicated foldings of the two cotyledonous leaves. This nut had a slightly bitter, but not unpleasant, aromatic taste.

### *Histology of the normal endocarp.*

Part of a transverse section of a normal nut is illustrated in fig. 9, the position of the area drawn being shown at the upper corner to the right. Near the surface are several tiers of sclerenchyma, its cells being of relatively small size, with thick walls of a light brown color and penetrated by numerous branching canals. The lumina of these dead cells and the canals are partially or completely filled with a dark brown deposit. They also contain characteristic crystals, often of relatively large size. Then follow several tiers of elongated cells, then a thicker stratum of sclerenchyma, whose irregular cells are cut in various planes. Finally the folded inner surface of the endocarp next to the meat is carpeted by a thin layer of deep brown color, the metamorphosed product of several strata of flattened cells.

*Histology of the abnormal endocarp.*

The dense outer shell of the abnormal nut (fig. 10) resembles closely in structure the normal endocarp just described, except that the tissue is rather more compact and the cells are smaller. (Compare figs. 9 and 10.) The cell-wall has a similar structure. There is the same kind of brown indurated matter filling the lumina of the cells, and the same kind of crystals are occasionally seen. The structure of the dense wall of the inner shell surrounding the nut is quite uniform, as represented in fig. 11, from a transverse section. The cell-walls in this are thick, laminated, and perforated by numerous canals, many of which branch and communicate with the canals of adjoining cells. (See cell *a*, fig. 11.) The brown indurated material frequently fills both canals and lumen.




The stem (figs. 1–*a* and 12) by which this inner nut was attached to the tree, is an interesting structure. As shown in the photograph, it has separated in one specimen from the nut, and terminates in a shallow cup or expansion which suggests the cupule of the acorn.

It is light in color streaked with dark brown lines, which assume the form of islands or irregular blotches at the expanded end next the nut. A section, cut in the plane indicated in fig. 12, has a singular appearance. It presents a finely mottled pattern, and when examined microscopically is seen to consist of colorless and colored sclerenchyma. The light brown cells, which owe their color to the indurated cell-contents, form a reticulated pattern. The tissue shows no direct or unmistakable evidence of imbrication in the plane sectioned, but I regret that the section did not pass through the axis of the stem.

The meat of the first abnormal nut (fig. 1, *c*) is represented in fig. 6, as it appears when removed from its inner shelly covering. The fact that the meat was white and fresh, and as already stated, not devoid of taste, after the lapse of twenty-one years, argues well for the density and impenetrability of its shelly coverings.

The parenchymatous cells near the surface of the cotyledon are smaller than in the normal hickory nut (*Carya sulcata*), and abound in starch and oil. In the normal nut the cells are of larger size and contain very much less starch and more oil.

The second nut (fig. 1, *e*) which I planted in earth after cracking the inner shell, failed to germinate, though I gave it warmth and moisture for several months. But since some acorns and other nuts which were planted at the same time and in the same pot, died, it is evident that the conditions of growth were for some unknown reasons unfavorable, and possibly under better auspices germination might have taken place.

Sections through the meat show two cotyledons, crumpled and folded upon each other in a very complex manner (figs. 7, 8). The parenchymatous cells appear to be normal. They are packed with minute ovoidal starch grains.

### *The origin of the abnormal variety.*

It has been seen that Dr. Kirtland considered this variation in the hickory as a result of hybridism with the oak, the only evidence of this being the peculiar form of the inner nut, resembling indeed an acorn in general appearance, the circumstances that the hickory was overshadowed by an oak, and the bitterness of the nut.

The fact that the inner nut resembles an acorn in general appearance, and is attached by a definite stem which ends in an expansion within the endocarp is indeed striking, but I find nothing in the histology of these parts to show that this resemblance is anything more than superficial. The sclerenchyma of the inner nut is far more like that of the endocarp of the hickory than that of the oak.

Supposing that hybridism between two such families of plants as the oak and the hickory possible, it could rarely happen since the oaks of this region flower a week or more in advance of the hickories. So that if hybridism did occur in this instance, the flowering of the one species must have been abnormally delayed, or that of the other abnormally accelerated.

On May 15th of this year I gathered some young nuts of the hickory near Cleveland which were perhaps a week old and measured over the exocarp in one case 5×8 millimeters. The

endocarp has at this early stage, as we would expect, the form characteristics of the mature nut. Normal fertilization thus leads very early to the normal outlining of the fruit.

While I can find no direct evidence of hybridism from a study of the minute anatomy of the structure, I consider it highly probable that this variation arose at the time of fertilization, which was in some way abnormal, and must content myself for the present with giving the known facts. When similar cases are discovered, they may afford botanists more secure ground for speculations in regard to their cause.*

Adelbert College, May, 1896.

## DESCRIPTION OF FIGURES.

FIGURE 1, Plate V.—*a*. Internal stem removed from abnormal nut (A).
*b*. Half of endocarp of abnormal nut (A), showing the "mould" of the stem and inner nut.
*c*. Half of endocarp (A) showing the internal acorn-like nut.
*d*. Half of endocarp of abnormal nut (B) from the outer side.
*e*. Half of endocarp of abnormal nut (B) from inside. In this case the fusion of the stem to the inner nut was more complete.
All from photograph. Natural size.

FIGURE 2.—Endocarp of *Carya sulcata* (Western Shell-bark Hickory). Lateral view. One-half natural size.

FIGURE 3.—Transverse section of the same, showing normally folded cotyledons within the shell. One-half natural size.

FIGURE 4.—Half of abnormal endocarp (A). Line drawing of fig. 1. *b*. One-half natural size.

FIGURE 5.—Endocarp of abnormal nut (A) seen in transverse section, showing outer shell, shell of inner nut (shaded black), and folded cotyledons. One-half natural size.

FIGURE 6.—Meat of abnormal nut (A) removed from inner shell, some of the tissue of the hilum clinging to the top. Natural size.

FIGURE 7.—Transverse section through the meat of abnormal nut (A) showing foldings of the cotyledons, in the plane indicated at the right. Four times natural size.

FIGURE 8.—Transverse section through meat of abnormal nut (A), showing foldings of the cotyledons, in plane indicated at the right. four times natural size.

FIGURE 9.—Part of transverse section of endocarp of normal hickory nut from point indicated at the right, showing superficial sclerenchyma, the tiers of deeper cells lying vertical to the surface. The cell-walls are pierced with numerous branching canals, and enclose crystals (possibly calcium oxalate) and secondary deposits of a brown color. ×124.

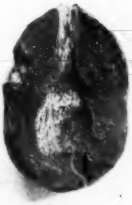
FIGURE 10.—Part of transverse section of abnormal endocarp (A), taken from a point near surface indicated at the right. ×124.

FIGURE 11.—Sclerenchyma from transverse section of shell of inner nut from point near surface shown at right. ×124.

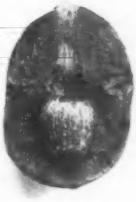
FIGURE 12.—Stem of abnormal nut (A). Lateral view. Enlarged about four times.

* The interesting communication, in Bulletin of the Torrey Botanical Club, 1880, p. 54, noting the occurrence of fruits having a very thick endocarp and possessing a transformed axis, should be examined in connection with the case here mentioned.

a



b.



c.

d.

e.

ART. XXXVI.—*The Separation and Identification of Potassium and Sodium;* by D. ALBERT KREIDER and J. E. BRECKENRIDGE.

[Contributions from the Kent Chemical Laboratory of Yale University—LVI.]

THE application of the spectroscope to the detection of potassium and sodium, for which there has thus far been no alternative, is not so unsatisfactory in the evidence as to the presence or absence of these elements as it is in its utter failure, except under delicate quantitative comparisons, to give any idea as to the quantity of either element indicated; and since the most minute quantity of either element is sufficient to produce its characteristic line in the spectroscope, together with the fact that so many of the reagents employed in analysis contain a trace of alkali, the indication of the spectroscope is rendered misleading. While to the careful observer the presence or absence of potassium is invariably revealed, all evidence as to the ubiquitous element sodium is practically worthless. It has, therefore, appeared advisable to us to undertake the following work looking toward a method for the direct determination of sodium based upon the principle of the perchlorate method for the quantitative determination of potassium. The fact that, in the form of the perchlorate, potassium is insoluble while sodium is readily soluble in 97 per cent alcohol, affords a means for the separation of the two elements as well as for the identification of the former. By converting the sodium in the filtrate from the precipitated potassium salt either to the chloride or sulphate, in which forms it is insoluble in alcohol, a means for the detection of sodium is also provided.

Assured by the experiments previously published by one of us,* that the determination of potassium according to this method would be sufficiently accurate, our experimentation was directed towards determining the conditions of greatest utility and delicacy for the detection of sodium. In converting the sodium from the perchlorate to the chloride, attempts were first made to substitute some soluble chloride for the free acid, the addition of which to the alcoholic solution of sodium perchlorate, it was feared, might result in the formation of the dangerously explosive compound, perchloric ether. But aniline hydrochloride, prepared by saturating a solution of aniline in absolute alcohol with gaseous hydrochloric acid, when applied to the precipitation of 0·010 grms. of sodium perchlorate dissolved in 5 $cm^3$ of 97 per cent alcohol, proved so hopelessly inadequate that we resorted immediately to the use of free acid, which, fortunately, was found perfectly safe

* Kreider, this Journal, vol. xlix, 448.

even in the presence of considerable perchloric acid and at the boiling point of the mixture.

The strongest aqueous solution of hydrochloric acid, however, is inapplicable, as was proved by several experiments in which as much as 0·010 grms. of sodium perchlorate, dissolved in only 5 cm³ of 97 per cent alcohol, failed to be revealed by the addition of the strongest aqueous solution of the acid, added in quantities varying from a single drop to 10 cm³—not the slightest turbidity being produced. By substituting for the aqueous solution of the acid, a saturated solution of hydrochloric acid in 97 per cent alcohol, of which 5 cm³ were used for the precipitation, quantities of from 0·002 to 0·003 grms. of sodium perchlorate dissolved in 5 cm³ of 97 per cent alcohol could be detected with certainty; but this could not be made sufficiently delicate. Concentrated sulphuric acid was also applied as the precipitant and was found reliable for quantities of about 0·003 grms. of sodium perchlorate dissolved in 10 cm³ of 97 per cent alcohol, when a single drop of the acid was added, but an excess of the acid caused the precipitate to redissolve. Gaseous hydrochloric acid proved most effectual. The dehydrating effect of the acid upon the alcohol greatly increases the insolubility of sodium and secures a remarkable delicacy, as is evident from the results recorded in Table I.

TABLE I.

| $NaClO_4$ taken. grms. | $Na_2O$ equivalent. grms. | 97% alcohol. cm³. | Indication. |
|---|---|---|---|
| 0·0100 | 0·00250 | 10 | very strong |
| 0·0050 | 0·00125 | " | strong |
| 0·0040 | 0·00100 | " | " |
| 0·0030 | 0·00075 | " | " |
| 0·0030 | 0·00075 | " | good |
| 0·0020 | 0·00050 | " | " |
| 0·0020 | 0·00050 | " | " |
| 0·0010 | 0·00025 | " | " |
| 0·0005 | 0·00012 | " | trace |
| 0·0003 | 0·00006 | " | " |
| 0·0001 | 0·00003 | " | none |
| 0·0000 | 0·00000 | " | " |
| 0·0010 | 0·00025 | 40 | distinct |

The sodium employed in these determinations was in the form of perchlorate, prepared by evaporating sodium chloride, free of potassium and ammonium, with perchloric acid until tests for hydrochloric acid proved a complete conversion to the perchlorate, when the excess of acid was volatilized by heating over a drying cone. Two grams of this purified salt were dissolved in 200 cm³ of 97 per cent alcohol and served for our standard solution for those tests in which quantities greater than 0·001 grms. of sodium perchlorate were used. When it

appeared evident that smaller quantities could be detected with certainty, a solution of the salt containing 0·050 grms per 100 $cm^3$ of water was used, and each portion evaporated to dryness before adding the alcohol. In each case the alcohol subsequent to its addition was saturated with gaseous hydrochloric acid, being kept cool by immersion in a beaker of water. For the generation of hydrochloric acid, the well known form of apparatus consisting of a side neck flask, containing sodium chloride covered with hydrochlo.ic acid fitted with a stoppered funnel, through which sulphuric acid could be admitted as desired, served admirably.

It is evident, then, that by the use of 10 $cm^3$ of 97 per cent alcohol with gaseous hydrochloric acid 0·0003 grms. of sodium oxide can be found with certainty; and when the alcohol is allowed to become saturated with the gas even 0·00006 grms. of sodium oxide will be unmistakably revealed. The quantity of alcohol, 10 $cm^3$, is sufficient for all purposes, since this amount will dissolve about two grams of sodium perchlorate; but even in 40 $cm^3$ 0·0002 grm. of sodium oxide may be seen distinctly; from which fact it is evident that this method can be applied to the quantitative determination of sodium. Absolute alcohol does not materially increase the delicacy of the test.

In Table II are recorded the results of experiments made upon mixtures of the two elements. The sodium and potassium taken were drawn from separate standard solutions containing one gram of the purified perchlorates in 100 $cm^3$ of distilled water. After evaporating to dryness on the steam bath, the residue was treated with the usual amount of 97 per cent alcohol, the insoluble potassium perchlorate was removed by filtering through a dry paper filter and dry funnel into a dry test tube, and the filtrate saturated with gaseous hydrochloric acid.

TABLE II.

| $KClO_4$ taken. grms. | $K_2O$ equivalent. grms. | $NaClO_4$ taken. grms. | $Na_2O$ equivalent. grms. | Indication for potassium. | Indication for sodium. |
|---|---|---|---|---|---|
| 0·0500 | 0·01699 | 0·0500 | 0·01250 | strong | strong |
| 0·0200 | 0·00680 | 0·0200 | 0·00500 | " | " |
| 0·0100 | 0·00340 | 0·0100 | 0·00250 | " | " |
| 0·0050 | 0·00170 | 0·0050 | 0·00125 | " | " |
| 0·0040 | 0·00136 | 0·0040 | 0·00100 | good | good |
| 0·0030 | 0·00102 | 0·0030 | 0·00075 | " | " |
| 0·0020 | 0·00068 | 0·0020 | 0·0005 | " | " |
| 0·0010 | 0·00034 | 0·0010 | 0·00025 | " | " |
| 0·0005 | 0·00017 | 0·0005 | 0·00012 | trace | trace |
| 0·0003 | 0·00010 | 0·0003 | 0·00007 | " | " |
| 0·0001 | 0·00003 | 0·0001 | 0·00003 | faintest trace | none |
| 0·0000 | 0·00000 | 0·0100 | 0·00250 | none | strong |
| 0·0100 | 0·00340 | 0·0000 | 0·00000 | strong | none |

These results prove that the two elements when combined in any proportion may be separated and identified with great delicacy.

Before applying this method, however, it is necessary to remove certain interfering substances. While potassium may be safely tested for in the presence of other bases and acids, except ammonium, cæsium and rubidium, and sulphuric acid* the large number of elements whose chlorides are insoluble in alcohol necessitates their removal before testing for sodium. But among the common alkalies ammonium is the only one whose presence is objectionable. Lithium does not affect either the test for potassium or sodium, as was determined by an experiment in which about 0·1 grm. of lithium chloride was converted into the perchlorate by evaporating with an excess of perchloric acid and treated with 10 cm³ of 97 per cent alcohol. A perfectly clear solution was obtained, which upon saturation with gaseous hydrochloric acid and cooling, remained clear. The removal of sulphuric acid is necessitated by the insolubility of sodium sulphate in alcohol.

TABLE III.

| Bases taken. Pb . Cu . Al . Fe . Zn . Ba . Ca . and Mg . as nitrates. grms. | | $K_2O$ taken. grms. | $Na_2O$ taken. grms. | Indication for potassium. | Indication for sodium. |
|---|---|---|---|---|---|
| 0·0500 | of each | 0·0000 | 0·0000 | faintest trace | trace |
| 0·0500 | " | 0·0017 | 0·0012 | good | good |
| 0·1000 | " | 0·0000 | 0·0000 | faintest trace | trace |
| 0·1000 | " | 0·0000 | 0·0005 | " " | good |

In the experiments made with potassium and sodium associated with other acids and bases, the results of which are recorded in Table III, the following treatment was adopted. The several groups of bases were successively removed in the ordinary way: Hydrogen sulphide in ammoniacal solution removed the lead, mercury, copper and zinc. Barium and calcium were removed by ammonium carbonate, the final filtrate being evaporated and ignited to the complete volatilization of ammonia. The residue was dissolved and treated with barium hydrate for the removal of magnesium, and after filtering the barium was again removed by ammonium carbonate and the filtrate evaporated and ignited as before. This residue was then treated with 10 cm³ of boiling water and after stirring was filtered in order to remove the organic matter usually found at this stage of the treatment. To the filtrate was added 0·1 to 0·5 cm³ of pure perchloric acid, about 1·7 sp. gr., according to the amount of residue, and evaporated over the steam bath until the white fumes of perchloric acid appeared. When the quantity of sodium is large it is safer to evaporate several times in order to secure a complete conversion to the per-

* Loc. cit.

chlorate, and in such case precautions must be taken to have sufficient of the acid present. Upon treating with 97 per cent alcohol the presence of potassium is revealed by an insoluble residue. This is removed by a dry filter and the filtrate saturated with gaseous hydrochloric acid, whereupon sodium, if originally present in amount greater than 0·0005 grms. of the oxide, will be precipitated in granular condition.

The fact that minute traces of sodium and potassium are found in the blank tests is to be expected from the delicacy of the method as proved by Tables I and II, when it is remembered that but very few of the so-called chemically pure reagents are absolutely free of sodium and that even distilled water kept in glass vessels contains a trace of the alkaline elements. However, the indication for sodium in the blank tests appeared only as a cloudiness and after complete saturation, while when the quantity of sodium oxide present is not less than 0·0005 the precipitate appears in granular form and before the alcohol is completely saturated, which leaves the method all that could be desired for qualitative determinations.

*Preparation of the Perchloric Acid.*—The perchloric acid prepared according to the method previously published by one of us,* by converting sodium chlorate into the perchlorate by heat, destroying the residual chlorate by treating with the strongest hydrochloric acid, from which the sodium chloride was separated by filtering through a Gooch filter and the excess of hydrochloric acid removed by evaporation—while answering perfectly well for the detection of potassium, is inapplicable to the test for sodium, because of the small amount of this element which the acid always contains, due to the partial solubility of sodium chloride in hydrochloric acid. As distillation seems the only method for the removal of this residual sodium, our attention was given to a study of the best conditions for the distillation. Various experiments led to the adoption of the following treatment, which we found in every case perfectly safe and fairly rapid. To prevent loss by decomposition the distillation must be carried on under diminished pressure, and unless the acid has been previously concentrated by evaporating until the white fumes appear, if there is any considerable amount of the acid in the distilling flask, even with porcelain chips to check it, it bumps with such violence as to throw the liquid to all parts of the flask and possibly into the condenser. It appeared to be essential, therefore, to start with only a small amount of the concentrated acid in an apparatus which would permit of the gradual addition of the acid without relieving the vacuum. Rubber stoppers or connectors are not advisably used where the acid may condense upon them and flow back into the flask. Invariably oxidizable matter is carried back,

* Kreider, this Journal, vol. xlix, 443.

causing explosions which vary in force and seriousness according to circumstances.

We, therefore, selected a strong distilling flask of about 100 $cm^3$ capacity and sealed into the tubulation a stoppered funnel which reached well into the bulb. The stop-cock of this funnel was carefully cleansed of vaseline and lubricated with metaphosphoric acid obtained by boiling syrupy orthophosphoric acid until the temperature of 350° C. had been attained.* The side neck of the flask was inclined upward for a short distance before being bent into the receiver, with which it was connected by a rubber stopper through which the tube extended for a safe distance. An ordinary bottle of 250 $cm^3$ capacity served for a receiver and was closed by a doubly perforated stopper. Through one of the perforations the adapter from the condenser was entered; through the other connection was made with a small glass bulb inserted between the receiver and the next tube, containing moistened sticks of caustic potash, in order to prevent the potash from reaching the receiver in case of an accident to the pump. The object of the potash was to absorb any chlorine resulting from the inevitable slight decomposition of the acid, and thus to protect the mercury of the pump. For the exhaustion an automatic pump was employed and generally twenty minutes would suffice to reduce the pressure to about $8^{mm}$, when the distillation was begun. The pump gradually reduced the pressure, which was kept at about 3 to $5^{mm}$. The bottom of the distilling flask was covered with a layer of fine porcelain chips to a depth of about 1 $cm^3$ and the whole flask was surrounded by a cylinder of thin sheet iron closed below, while the upper opening was protected by an albestos cover. By this means heat was uniformly applied to every part of the flask and up to the point at which, if the acid condensed, it would flow into the receiver. Three or 4 $cm^3$ of the acid were admitted to the flask, after which the temperature was raised to about 130° C. and the acid admitted at about the same rate that it dropped from the condenser, care being taken to prevent the liquid in the distilling flask from disappearing entirely. No danger was experienced in admitting the acid; the porcelain chips distribute the heat and prevent the colder acid from reaching the glass.

Careful compliance with the above conditions will secure satisfactory results. As a rule we succeeded in distilling at the rate of 25 $cm^3$ to 40 $cm^3$ per hour, and when it is remembered that the product is the dihydrate of perchloric acid, the most concentrated form in which it is stable, and of which 0·1 grm. of potassium oxide requires only 0·16 $cm^3$, it will be seen that by this process the acid may be prepared without great difficulty.

* This lubricant will be found entirely satisfactory and greatly preferable to vaseline in many other operations where the greasy effect of the latter is objectionable.

## Art. XXXVII.—*On the Estimation of Cadmium as the Oxide;* by Philip E. Browning and Louis C. Jones.

[Contributions from the Kent Chemical Laboratory of Yale University—LVII.]

In an article entitled "The Estimation of Cadmium" * Max Muspratt discusses critically some of the methods in use for the determination of that element. Muspratt finds that the method which involves the precipitation as carbonate, ignition and weighing as oxide gives low results, and he accounts for these results by the well known tendency of cadmium to reduction, especially in the presence of organic matter. To avoid this reduction he dissolved the precipitated carbonate in nitric acid, evaporated to dryness on a water bath, and gently ignited the nitrate to the condition of the oxide. This treatment also gave low results, although the oxide obtained from the ignition of the nitrate was found to contain traces of sulphate from the solution of the cadmium sulphate used. A second method of treatment was to filter and dry the precipitated carbonate and remove as much of it as possible to a weighed porcelain crucible, ignite and weigh by itself. This oxide was found to be free from traces of sulphate.†

The remainder of the cadmium oxide adhering to the paper was dissolved in pure nitric acid and the solution and rinsings evaporated to dryness and ignited in a weighed crucible and weighed. Here also low results were obtained which, after the extended process of manipulation, would scarcely seem surprising. If, however, Muspratt adds, the oxide obtained from the ignition of the carbonate be taken as $Cd_2O$ the results are satisfactory.

A third modification gives more satisfactory results. The method of treatment is the same as the last mentioned, except that the oxide obtained from the ignition of the carbonate is ignited in a stream of oxygen until no further increase in weight results.

In a former paper from this laboratory‡ one of us made use of the carbonate method for the determination of cadmium after having separated that metal from copper, The filtration was made on asbestos in a Gooch crucible and the results were most satisfactory. The object of the work to be described is to show that when the carbonate is filtered upon an asbestos felt previously ignited the dangers of reduction are obviated and the carbonate process is both simplified and placed among good analytical methods. The solution used for the work was one of cadmium sulphate, and the standard was determined by evaporating measured and weighed portions to dryness in the

* Jour. Sci. Chem. Industry, vol. xiii, 211.

† Muspratt's theory is that in the ignition of the carbonate the sulphate is dissociated, while the ignition of the nitrate does not effect this result.

‡ Browning, this Journal, vol. xlvi, 280.

presence of a few drops of sulphuric acid, igniting at low redness, and weighing as the anhydrous sulphate. The average of several closely agreeing results was taken as the standard. Measured and weighed portions of this solution were diluted to about 300 $cm^3$ with hot water and a solution of potassium carbonate, 10 per cent, added drop by drop with constant stirring until no further precipitate was obtained. The precipitate was then boiled for about fifteen minutes, when it became granular and settled quickly. It was then filtered upon asbestos, washed thoroughly, dried, and ignited at red heat until a constant weight was obtained. In several instances the weighed oxide was treated with a drop of nitric acid, again ignited and weighed, but in no case was there a perceptible change in weight. In the following table the results are tabulated.

| No. | CdO taken. grm. | CdO found. grm. | Error. grm. |
|---|---|---|---|
| (1) | 0·1140 | 0·1143 | 0·0003 + |
| (2) | 0·1142 | 0·1137 | 0·0005 — |
| (3) | 0·1141 | 0·1148 | 0·0007 + |
| (4) | 0·1141 | 0·1148 | 0·0007 + |
| (5) | 0·1142 | 0·1146 | 0·0004 + |
| (6) | 0·1143 | 0·1147 | 0·0004 + |
| (7) | 0·1143 | 0·1144 | 0·0001 + |
| (8) | 0·1139 | 0·1146 | 0·0007 + |
| (9) | 0·1270 | 0·1272 | 0·0002 + |
| (10) | 0·1279 | 0·1283 | 0·0004 + |
| (11) | 0·1272 | 0·1281 | 0·0009 + |
| (12) | 0·1278 | 0·1281 | 0·0003 + |
| (13) | 0·2556 | 0·2561 | 0·0005 + |
| (14) | 0·2550 | 0·2547 | 0·0003 — |
| (15) | 0·1272 | 0·1279 | 0·0007 + |
| (16) | 0·1281 | 0·1288 | 0·0007 + |
| (17) | 0·1274 | 0·1278 | 0·0004 + |
| (18) | 0·1284 | 0·1290 | 0·0006 + |
| (19) | 0·1271 | 0·1277 | 0·0006 + |
| (20) | 0·1278 | 0·1285 | 0·0007 + |
| (21) | 0·2555 | 0·2555 | 0·0000 ± |

As will be noticed, the results show a plus error which might naturally be due to a slight inclusion of the alkali carbonate. To test the truth of this hypothesis, a portion of the oxide which gave a plus error of 0·0007 grm. was dissolved and tested for potassium by the perchloric acid method* and an amount of that element was found equal to 0·0006 grm. of the carbonate. Another portion of the oxide which showed no error was similarly treated and only 0·0002 grm. on the carbonate was found. The results show, as we think, that the carbonate method can be successfully applied to the quantitative estimation of cadmium without recourse to the tedious process of manipulation recommended by Muspratt.

June, 1896.

* Kreider, this Journal, vol. xlix, 443.

ART. XXXVIII.—*The Determination of Tellurium by Precipitation as the Iodide;* by F. A. GOOCH and W. C. MORGAN.

[Contributions from the Kent Chemical Laboratory of Yale University.—LVIII.]

IT was known to Berzelius that hydriodic acid and tellurous acid interact with the formation of tellurium tetraiodide, which is converted by water into an oxyiodide and by excess of an alkaline iodide into a soluble double salt. Wheeler* has shown that the double salt which is formed when tellurous iodide is boiled in a strong solution of potassium iodide in dilute hydriodic acid is definite and has the constitution represented by the formula $2KI . TeI_4 . 2H_2O$. We have observed, however, that when potassium iodide is added to a cold solution of tellurous acid containing at least one-fourth of its volume of strong sulphuric acid, no tendency toward the formation of a double salt becomes apparent until the potassium iodide amounts to more than enough to convert all the tellurous acid present into the tetraiodide according to the equation,

$$H_2TeO_3 + 4H_2SO_4 + 4KI = TeI_4 + 4KHSO_4 + 3H_2O.$$

The tellurium tetraiodide which is thus formed is extremely insoluble in sulphuric acid of the strength mentioned, though soluble in excess of potassium iodide, and acted upon by water with the formation of tellurium oxyiodide and hydriodic acid. It is produced at first in the condition of a finely divided dark brown precipitate which upon agitation of the liquid containing it gathers in curdy masses and settles, leaving the supernatant liquid clear. By taking advantage of this tendency to curd it is possible to determine without great difficulty the exact point during the gradual addition of potassium iodide when the precipitation of the tellurium iodide is complete, and we have been able to found upon this property a very simple titrimetric method for the direct determination of small amounts of tellurium.

In our test experiments we used tellurium dioxide prepared by oxidizing presumably pure tellurium with nitric acid and igniting the residue at a low red heat. Weighed amounts of the oxide thus prepared were dissolved in Erlenmeyer beakers in a very little of a strong solution of potassium hydroxide, and dilute sulphuric acid was added carefully until the tellurous acid which was precipitated upon the neutralization of the alkaline hydroxide was just redissolved. To this solution sulphuric acid of half-strength was added in such amount that the solution finally obtained, after adding the aqueous solution of potassium iodide subsequently, should still contain at least

* This Journal, xlv, 267.

one-fourth of its volume of strong sulphuric acid. The Erlenmeyer beaker was placed upon a pane of window glass supported upon strips of wood about 1$^{cm}$ above the level of the work table, which was covered with white paper. A solution of approximately decinormal potassium iodide free from iodate and carefully standardized in terms of iodine by a method described in a former paper from this laboratory* was introduced gradually from a burette into the middle of the Erlenmeyer beaker. As the drops of the potassium iodide touched the liquid the precipitation formed at the center and traveled in rings toward the outer walls of the beaker. When the liquid became so opaque that the effect of the potassium iodide was distinguished with difficulty, the beaker was rotated and the curded precipitate permitted to settle, and then the process of titration was continued as before. We experimented with amounts of tellurium dioxide varying from approximately 0·025 grm. to 0·1 grm., the latter quantity being as large as can be handled with accuracy without intermediate removal of the precipitate by filtration. With an Erlenmeyer beaker 10$^{cm}$ in diameter across the bottom and a final volume of liquid amounting to not more than 100 cm$^3$, we were able to follow the precipitation most easily.

The results of a series of determinations made according to the method described and recorded in the following table are closely accordant, and, in close agreement with the theory of the process if the atomic weight of the tellurium which we used is taken as 127. We feel justified in taking this number as the atomic weight of our tellurium, because the mean result of twelve oxidations by standard potassium permanganate of tellurium dioxide, prepared similarly to that which we used and from the same lot of material, and the mean result of twelve reductions by hydrobromic acid of the telluric acid thus produced,† point to this figure.

| Final volume. cm$^3$ | Strongest $H_2SO_4$ present. cm$^3$ | Iodine value of KI used. grm. | $TeO_2$ taken. grm. | $TeO_2$ found. grm. | Error. grm. |
|---|---|---|---|---|---|
| 50 | 17 | 0·0706 | 0·0223 | 0·0221 | 0·0002— |
| " | " | 0·0764 | 0·0244 | 0·0239 | 0·0005— |
| " | " | 0·1591 | 0·0496 | 0·0499 | 0·0003+ |
| 60 | " | 0·1655 | 0·0517 | 0·0519 | 0·0002+ |
| " | " | 0·1578 | 0·0498 | 0·0494 | 0·0004— |
| 80 | 30 | 0·1591 | 0·0498 | 0·0499 | 0·0001+ |
| 100 | " | 0·3179 | 0·1001 | 0·0997 | 0·0004— |
| " | " | 0·3186 | 0·1008 | 0·0999 | 0·0009— |
| " | " | 0·3208 | 0·1011 | 0·1005 | 0·0006— |
| " | " | 0·3208 | 0·1010 | 0·1005 | 0·0005— |

From these results it is obvious that the method, which is very rapid, is accurate.

* This Journal, xxxix, 188; xlv, 334. † Ibid., xlviii, 377 and 378.

## Art. XXXIX.—*Notes on some Mesozoic Plants from near Oroville, California;* by Wm. M. Fontaine.

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During the season of 1894, Mr. T. W. Stanton made a small collection of fossil plants from near the Banner Mine in the vicinity of Oroville, California. They were sent to Mr. Lester F. Ward and by him submitted to me for determination. As the plants indicated an interesting flora, not hitherto known in the Mesozoic formations of America, suggesting, possibly, the existence of true Jurassic plants in the United States, Mr. Ward visited the locality in September in 1895, for the express purpose of making, if possible, additional collections. He was so fortunate as to find, in the same vicinity, exposures of the strata, unknown to Mr. Stanton, that were rich in fossils. Mr. Stanton's imperfect collection left the age of the formation yielding the plants in considerable doubt, which the larger one of Mr. Ward with its better preserved impressions served in large measure to remove. Mr. Ward's specimens also were submitted to me, and it is the object of this paper to briefly give some of the results obtained from the study of all the material now in hand from Oroville.

In order that the reader may have some idea of the occurrence of the fossils, it will be necessary to give a few preliminary statements regarding the geology of the region.

Mr. Ward collected from four localities, all in the immediate vicinity of the Banner Mine, and in these are included those that afforded the plants of Mr. Stanton. The plants were all found on the same geological horizon. As Mr. Ward informs me, the strata yielding the plants occur in a narrow belt, a few hundred yards wide, with a dip of 70°–80°. They resemble, lithologically, the Jurassic Mariposa Slates, but, as they have hitherto yielded no fossils, and are connected stratigraphically with no known formation, their age is, as yet, not determined. Mr. W. H. Turner in a paper, "On the Age and Succession of the Igneous Rocks of the Sierra Nevada," published in the Journal of Geology, vol. iii, No. 4, May–June, 1895, p. 394, in speaking of the eruptive rocks of the Smartsville area, says, "These rocks, largely augite porphyries and their tuffs, are presumed to have covered, as with a mantle, the underlying Paleozoic formations. There are some streaks of slate among the eruptive masses, but these have not, in the Smartville area, afforded any fossils. However, during the past season, in the northern extension of the same area, in a belt of clay slate interbedded with augite breccia and tuff, fossil plants were collected by T. W. Stanton. The exact locality is, by the stage

road, south of the Oroville Table Mountain, near the Banner gold quartz mine."

These are the plants referred to in the beginning of this paper.

Mr. Ward's collection, although much larger than that of Mr. Stanton, and containing better preserved specimens, still shows very imperfectly the character of a number of plants. Enough is made known, however, to prove that they are distinct species, but either the amount of material, or the state of preservation, does not suffice to fix with precision the identity or the affinity of the form. It is for this reason that the location of certain plants in the following list is left in doubt. The list below gives the plants made out with more or less definiteness from the Oroville beds.

*List of Plants from the Oroville beds.*

1. Chadophlebis* spectabilis, Heer.
2. " argutulus, "
3. " Whitbiensis tenuis, var. *a*, Heer, species.
4. " densifolia, n. sp.
5. " Indica ?, Old and Mor.
6. Adiantites Orovillensis, n. sp.
7. Thyrsopteris Maakiana ?, Heer.
8. Pecopteris gleichenoides ?, Old. and Mor.
9. Tæniopteris Orovillensis, n. sp.
10. Angiopteridium Californicum, n. sp.
11. Sagenopteris rhoifolia ?, Presl.
12. Macrotæniopteris Californica, n. sp.
13. " nervosa, n. sp.
14. Pterophyllum Rajmahalense ?, Mor.
15. Ctenis grandifolia, n. sp.
16. " auriculata, "
17. " Orovillensis, "
18. Ctenophyllum Wardii, n. sp.
19. " angustifolium, n. sp.
20. " grandifolium, var. Storrsii, n. var.
21. " densifolium, n. sp.
22. Podozamites lanceolatus, [L. and H. spec.] Schimp.
23. " " var. latifolius, Heer, var.
24. Pinus Nordenskiöldi ?, Heer.
25. Pagiophyllum Williamsoni, [L. and H. spec.] Heer.
26. Carpolithus Storrsii, n. sp.
27. Undetermined Cone.

Whatever may be the true place of these 27 forms, they are all different. The flora does not seem to have had great variety, but judging from the number of specimens, such

*I prefer the name "Cladophlebis" for these plants, which Heer regards as Asplenium.

plants as *Tæniopteris Orovillensis*, *Podozamites lanceolatus*, and *Ctenophyllum densifolium*, were very common, *Ctenis auriculata*, *C. grandifolia*, *Ctenophyllum grandifolium*, var. *Storrsii*, were less abundant, but still common. The rest occur more rarely, and some, such as *Adiantites Orovillensis*, are found only in a single specimen. The plants, considered in their identical and most nearly related forms, range in time from the Rhetic, or uppermost Trias, to the Potomac. No plant is identical with any belonging to the Potomac, and only a single one, *Ctenophyllum Wardii*, has relationship with a Potomac form, viz.: *Ctenophyllum latifolium*, Font. There can then be no doubt that the age is not Potomac. The following plants do not show a sufficiently near relationship with known species to indicate any particular age: *Adiantites Orovillensis*, *Macrotæniopteris nervosa*, *Ctenis grandifolia*, *C. auriculata*, *C. Orovillensis*. Compared with uppermost Trias and Rhetic plants, we find, in the Oroville flora, one whose identity is doubtful, viz.: *Sagenopteris rhoifolia*, and four which show pretty close relationship. They are as follows: *Ctenophyllum angustifolium*, which is much like *C. Braunianum*; *C. densifolium*, *C. grandifolium*, var. *Storrsii*; which are near, the latter especially, *C. grandifolium* of the older Mesozoic of Virginia; *Tæniopteris Orvillensis*; which is much like *T. tenuinervis*, of the Infra-Lias (Rhetic) of France. As most of these are common plants in the Oroville flora, there is in it a pretty strong element indicating, by relationship not identity, an age near the beginning of the Lias. If we make a distinction between the members of the Jurassic as Lias and Oolite, and if we admit, as we probably should, the correctness of Feistmantel's contention, that the age of the Rajmahal Series is Liassic, we find a strong element in the Oroville flora pointing to both a Liassic and Oolitic age for it.

Three of the plants are doubtfully identified with Liassic ones, viz.: *Pecopteris gleichenoides?*, *Cladophlebis Indica?*, and *Pterophyllum Rajmahalense?*, and three show affinities with forms of that age. These are *Cladophlebis densifolia*, *Angiopteridium Californicum*, *Macrotæniopteris Californica*; six of the plants occur in the lower Oolite, and two are identified doubtfully with lower Oolite species. The six Oolite forms are *Cladophlebis spectabilis C. argutulus*, *C. Whitbiensis tenuis*, var. *a*, *Podozamites lanceolatus*, *P. lanceolatus latifolius*, *Pagiophyllum Williamsoni*. The two doubtful forms are: *Thyrsopteris Maakiana* and *Pinus Nordenskiöldi*.

From this it will be seen that the evidence that the age is Jurassic, is stronger than that for any other, and as the Oolitic plants predominate, we may assume with considerable probability, that it is rather late Jurassic, being about that of the lower Oolite.

University of Virginia, August 11th, 1897

## Art. XL.—*On a New Method for Reading Deflections of Galvanometers;* by C. B. Rice.

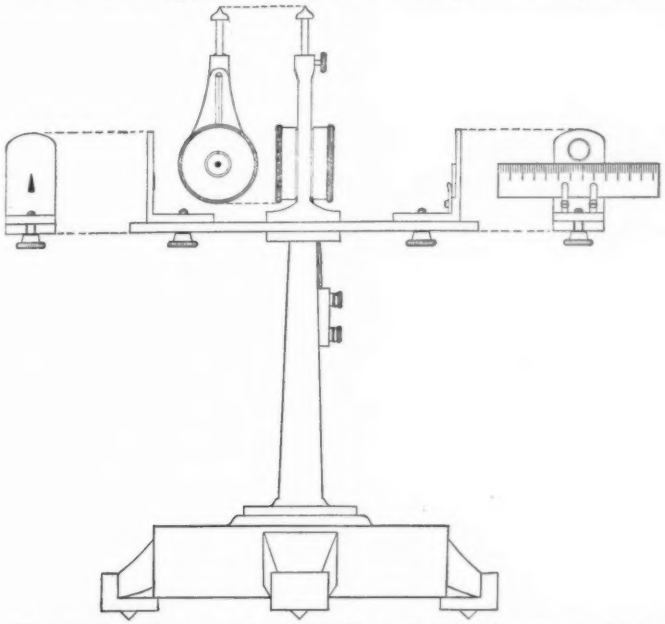
A method of reading deflections of galvanometer needles and analogous apparatus has been recently devised in this laboratory by Professor C. S. Hastings, which, since it proves to have considerable value, he has given me the opportunity to describe.

There are two types of sensitive galvanometers in general use, namely, those in which the deflections of the suspended system are determined by the motion of an image of a luminous source on a scale, and those in which the deflections are measured by telescope and scale after the method first introduced by Gauss and Weber. The Thomson galvanometers are the familiar examples of the first, and the Wiedemann of the second.

Each of these has certain inconveniences. That of Thomson, although an exceedingly sensitive galvanometer, requires a darkened room and a lamp, with somewhat inaccurate determination of the angle of deflection. It is also rather too delicate to put into the care of the untrained student. Wiedemann's is much better suited for ordinary laboratory work. Here less sensitiveness is compensated by much greater precision of angle measure, while its construction renders it safe to put the instrument into comparatively unskillful hands. A much wider range of sensitiveness and of damping is readily secured in this form than in Thomson's. It has, however, the inconvenience of requiring the rather expensive accessory of a telescope and scale and also of demanding a large amount of space in its employment. These disadvantages are not of such great moment in most cases, perhaps, to forbid its use, and in our laboratory we found such instruments, well constructed of metal throughout, thoroughly satisfactory until continuous disturbances of magnetic field in the region were brought about by the construction of an electric road. Experience showed that the sensitiveness was thus reduced to about one-tenth its former value. D'Arsonval galvanometers of course eliminated this difficulty, but they too have their inconveniences and limitations.

If the linear dimensions of a Wiedemann's galvanometer were sufficiently reduced, say $n$-fold, the sensitiveness would be increased, while the accuracy of determination of duration would be decreased in the same ratio, since the apertures of the optical apparatus are thus reduced. If this were carried far enough, the aperture of the telescope would be reduced to that of the pupil of the eye and might be dispensed with

without loss. On the other hand, the disturbances of the field being no greater than before would now have $n$-fold less effect. Hence, in an irregularly variable field such an instrument would be $n$-times as accurate. In practice the gain is really much greater than this because of the much reduced period of the needle. These disturbances must be regarded as perfectly irregular in the larger instrument, but may here be treated as sudden occasional changes separated by periods of quiescence. A galvanometer constructed on this theory, as developed by Professor Hastings, has been tried with very satisfactory results.



The magnet is a circular steel disk of $1^{cm}$ diameter polished on both sides for convenience, serving as a mirror, hung between two coils of wire with a silk suspension of about $5^{cm}$. The coils are of number 36 wire with an outside diameter of $2{\cdot}5^{cm}$ and have a resistance each of six ohms. The brass covers which fit over the coils are provided with openings closed by glass so that there is a clear view of both faces of the magnet, while air currents are excluded. A small aperture of $1{\cdot}4^{mm}$ diameter in the center of the steel mirror permits a view of objects beyond, which lie sufficiently near the axis of the instrument. Facing the coil and the magnet within, but at a trifle higher level, is placed a small lens at a distance adjustable from 5 to $7^{cm}$ from the magnet. On the opposite side, at a similar adjustable distance from the mirror, is fixed a fine

point, preferably of some dark material with a white background. Directly under the lens is a small scale. The image of this scale as formed by the mirror is seen superimposed upon the image of the fixed point as seen through the aperture in the mirror, and any change in the angular position of the mirror causes a relative shifting of these two images, which, under proper adjustment, are in the same plane and are, therefore, perfectly free from errors of parallax. The use of the lens serves the double purpose of reducing the linear dimensions of the apparatus and of giving such precision to the ocular accommodation that the edges of the hole in the magnet as well as the fixed image of the scale due to the glass windows are so far out of focus as to be quite invisible. When the lens, point and small scale are once adjusted the instrument is ready for use at any time with no further attention. If the support be moderately level no leveling screws are necessary.

With this galvanometer a potential of $\frac{1}{100.000}$ of a volt is readily detected by repeated closing of the circuit—a sensitiveness which is more than sufficient for a large part of the elementary work of the laboratory.

The simplicity and cheapness of this type of galvanometer make it very desirable, while its lack of delicacy is of considerable moment where the care of it falls upon the novice.

There seems to be no reason why this method for reading deflections should not be used with all other galvanometers as a substitute for the telescope and long scale. The angular measures are read with great accuracy and with much greater precision than with the lamp and scale of Thomson's method. The small scale used in this connection should be divided into half millimeters, for the reading is made with clearness to tenths of such an interval.

The instrument figured is one of those constructed at this laboratory and must be looked upon simply as an example of a convenient, moderately sensitive, but widely useful form. The two coils are separated by a copper ring about $3^{mm}$ in thickness which produces a certain damping, although the galvanometer serves very well for ballistic use. Notwithstanding the moderate damping, the actual time required to secure a succession of readings is certainly not greater than is found necessary in using a Wiedemann aperiodic galvanometer, because the period is so greatly reduced. In an astatic system with long period more effective damping would doubtless be desirable, but in such a case there would be no difficulty in employing Thomson's ingenious air damping.

It is obvious that a needle constructed of small steel magnets cemented to silvered glass, the silver being removed from a small portion, might replace, and in some cases advantageously, our steel mirror.

Physical Laboratory, Sheffield Scientific School.

ART. XLI.—*On Crystal Measurement by means of Angular Coördinates and on the Use of the Goniometer with two Circles;** by CHARLES PALACHE.

THE methods of crystal measurement in general use at the present time are based on the determination of the *interfacial angles* from which are deduced the system and elements of the crystal and the symbols of the forms.

There is, however, another system of measurement which leads to these results more simply and more directly. We may term it the measurement of crystals by determination of *angular coördinates.*

In the familiar spherical projection the crystal faces are represented by the points of intersection of the face-normals with the surface of a sphere described about the crystal center. The relations of these points upon the sphere are known, if we determine the angular distances between them (measurement of interfacial angles) or if we determine the position of each one with reference to a set of coordinates (measurement by angular coördinates). These operations are strictly analogous to well known geographical operations; the first is comparable to triangulation, or the measurement of angular distances between points on the earth's surface; the second is like the determination of localities by latitude and longitude—that is, by reference to an equator and a meridian as fixed coördinates. The latter operations are so nearly alike that it is found convenient to retain the geographical terms for the crystallographic coördinates, and we accordingly speak of the equator and meridian of the crystal.

Any great circle of the sphere of projection may be taken as equator and the pole will lie at a distance of 90° therefrom. Any great circle at right angles to the equator may be taken as first meridian. In practice the choice of coördinates is limited to a few cases.

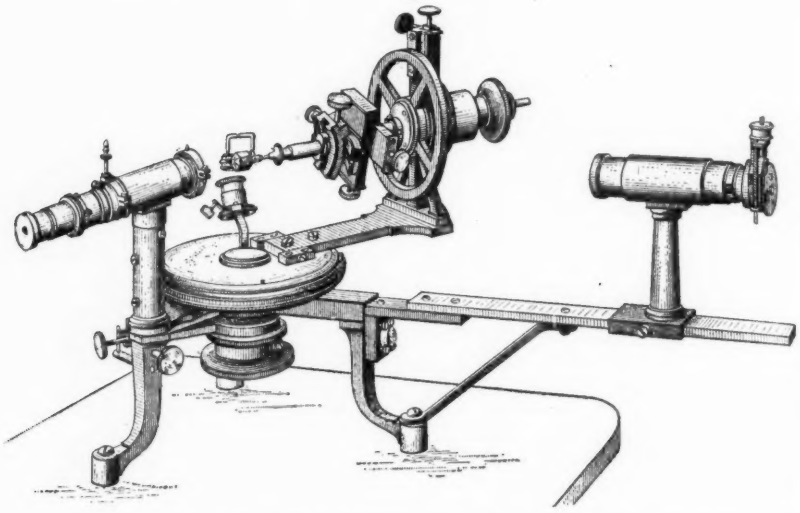
The means of applying this principle to crystal measurement is found in the *goniometer with two circles*† of which fig. 1 is

* A better name for this instrument than the literal translation of its German title (zweikreisiges goniometer), given above, is highly desirable but has not occurred to the writer. Neither of the names employed by Fedorof "Universal-(Theodolith-) goniometer" seems fully or correctly descriptive. Some such term as dicircle or biaxial goniometer may be found to be as simply descriptive as any.

† The instrument here shown is the original one constructed for Prof. V. Goldschmidt. Minor changes have since been introduced into its construction, which, however, do not affect its principle. It, as well as the other instruments to be described, is made by the mechanic P. Stoë, Jubiläumsplatz 70, Heidelberg, and the writer can testify to the careful and thorough construction. The same

an illustration. Its construction is best explained by reference to the outline view and plan, figs. 2 and 3. H is the horizontal circle revolving about the axis $h$, graduated and provided with fine adjustment and vernier. Rigidly attached to H by an arm and at right angles to it is the vertical circle V revolving about the axis $v$ and also graduated and provided with fine adjustment. The axis $v$ supports an adjusting device such as is found on the ordinary goniometer and upon it the crystal is mounted by means of a carrier $m$ capable of independent adjustment.*

1.



The collimator C and telescope F are horizontal; they may be moved relative to each other and the angle between them measured.

By revolution of V (from an arbitrary zero through an angle $\phi$) each face of the crystal may be brought perpendicular to H. By revolution of H (through angle $\rho$ from arbitrary zero) the face may be brought perpendicular to S, the bisectrix of the angle C$\hat{h}$F, also and will then reflect the signal upon the crosshairs of the telescope. The angles $\phi$ and $\rho$, read upon the vertical and horizontal verniers respectively, determine the

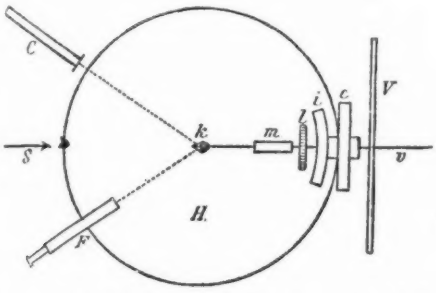
principle and a similar construction are employed in the Universal-(Theodolith-) goniometer (Zeitschr. f. Kryst., xxi, 1893, p. 514) devised by Fedorof and constructed by Fuess of Berlin and the instrument of Czapski (Zeitschr. f. Instrumentenkunde, 1893, i) is also similar.

* See description of this convenient device (Krysttallräger) in Zeitschr. f. Kryst., xx, 1892, p. 344; idem xxv, 1896, p. 541.

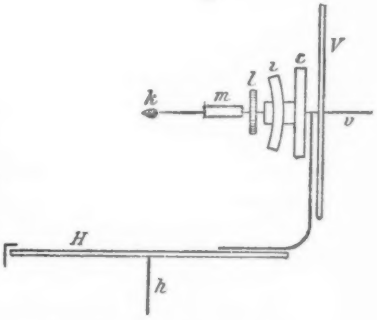
position of the crystal face with reference to the arbitrary coördinates. They may be termed the angular coördinates (Winkelcoördinaten), of the face. If the equator is taken parallel to V and if H is the first meridian, then angle $\phi$ corresponds to the geographical longitude, angle $\rho$ to the pole elevation (complement of the geographical latitude).

In practice, whenever possible, the crystal is so mounted that the prism zone is perpendicular to V; or, what is the same, the plane perpendicular to the prism zone, a cube face in regular system, a pinacoid in hex., tetrag., and orthorhombic systems, is taken as the *pole*. A face of the prism zone, preferably a pinacoid, is then taken as first meridian.

2.




3.




If this normal position cannot be used owing to absence or imperfection of the prism zone, another plane is taken as *pole* and preferably a face perpendicular to one of the other two axial zones. The elements and symbols so obtained are readily transformed to the normal form by interchange of axes.

It is evident that for a given position of collimator and telescope the value of $\rho = h_0$ for the polar position of the vertical circle will be constant and will serve for any plane adjusted parallel to V. This value, $h_0$, is found as follows: A reflecting surface is mounted, centered, and brought to reflection by turning H and V. Let the reading on H be $h_1$. V is then turned through 180° and the surface again brought to reflection by turning H. Let this reading be $h_2$. The required value, $h_0 = \frac{1}{2}(h_1 + h_2)$. This value may be checked and improved by repeated measurements on other surfaces. $h_0$ being known, the adjustment of a crystal face ($f$) in polar position is thus carried out.

Case I. The face ($f$) present and giving a good reflection.

The crystal is fixed upon the adjustment table with hard cement as near the desired position as may be and a corner of

the face is centered. H is now brought to the reading $h_0$ and the reflection from $f$ centered on the crosshairs by use of the adjusting tables. When properly adjusted, that is when parallel to V, the reflected signal should remain stationary on the crosshairs during a revolution of V.

Case II. The pole face ($f$) defined by a zone perpendicular to it (prism zone in general).

An edge of the prism zone is centered and adjusted to the horizontal crosshair. H is clamped at $h_0+90°$ and the reflections from two adjacent faces of the zone are brought to the center of the crosshairs by means of adjusting tables. H is then loosened, the edge again centered and the whole repeated as often as necessary. Other faces of the zone are then examined and if necessary the adjustment bettered. When the prism zone is thus adjusted at $h_0+90$, $f$, the pole face, is at $h_0$ and if present its reflection should be on the crosshairs when $H$ is brought to $h_0$. This case is important since the plane at right angles to the prism zone is the normal plane of projection in all systems and this position gives simple and direct results in the calculation. The prism zone is rarely lacking entirely and even when its faces are poor or striated its correct adjustment is possible.

For adjustment in the many other cases that may arise reference is made to the original papers.* The crystal once adjusted, each face is brought to reflection by movements of H and V and the angles $\phi$ and $\rho$ observed. If both ends of the crystal are developed, it is inverted after measurement of one end, the same zone being made equatorial and the same meridian being used. If the readings in the new position be $\phi'$ $\rho'$, then

$$180°-\rho' = \rho.$$
$$-\phi' = \phi.$$

The value $\phi_0 = h_0$ is subtracted from all the values found for $\phi$. The value $\rho_0 = v_0$ (for the first meridian) is similarly subtracted from all the values for $\rho$ and the resulting values, $\phi-\phi_0 = \varphi_1$, $\rho-\rho_0 = \rho_1$ are the angular coördinates of the faces.

The angles thus determined for each face are evidently quite independent of any other face and give an absolute picture of the crystal as it is, quite free from the approximations and averages introduced when the measurement is by zones as is now usual. If desired they give likewise the interfacial angles and (what cannot be measured by the other method) the angles of the zones or edges.

*V. Goldschmidt, Goniometer mit zwei Kreisen, Zeitschr. fur Kryst., xxi. 1893, p. 215. Polarstellen am zweikreisigen Goniometer, idem, xxiv, 1895, pp. 610–613.

The discussion of the results may proceed directly, but is simplified and hastened by the use of the graphical method. This is based upon the *gnomonic projection.* In this projection the crystal faces are represented by the points of intersection of the face-normals with a plane tangent to the sphere of projection and preferably normal to the chief zone of the crystal. Thus in general the plane of projection is chosen parallel to the vertical circle V of the goniometer, that is, normal to the prism zone of the crystal as usually mounted.

4.

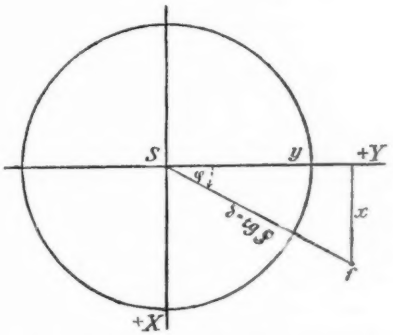



Figure 4 shows a gnomonic projection. $S$ is the projection of the pole face or the face normal to the prism zone. The circle described about $s$ as center (Grundkreis) has a radius, $r$, equal to the distance from the crystal center to the plane of projection. X and Y are the projections of the axes $a$ and $b$. If $r = 1$ and SY is taken as first meridian, then the position of a face, $f$, is given directly in the projection by its angular (polar) coördinates $\delta = tg\ \rho$ and $\phi$. Or it may be located by the rectangular coördinates derived from the first,

$$x = \sin \phi\ tg\ \rho.$$
$$y = \cos \phi\ tg\ \rho.$$

The values for $x$ and $y$ may be calculated for each face from its $\varphi_1$ and $\rho_1$ and plotted on ruled paper very rapidly, and this projection gives a direct picture of the crystal showing its degree of symmetry and the relations of its faces. Both measurement and projection are the same for all systems, and, if unknown before, the symmetry of the crystal may be found from the projection.

If the distance from crystal center to plane of projection ($= r$) be taken as unity, and axis $c$ equal to $r$, then in the rectangular systems the values of $x$ and $y$ for the unit form which are measured in the directions of the $a$ and $b$ axes respectively,

give directly the axial values $a:b:c(=1)$, which are readily transformed to the usual form, $a:b(=1):c$ by interchange of axes.

In the monoclinic system the additional elemental value, angle $\beta$, is found directly by the angular distance from the pole S to the projection of the basal plane.

In like manner in the triclinic system the angles $\alpha$, $\beta$, $\gamma$ are found in the projection if the pinacoidal planes are present, or by calculation if sufficient values are given by the measurement.

The unit form being chosen in the projection, the symbols of the other forms may be read off directly by measurement of their coördinates in terms of the axial units, and the symbols so obtained are the same as the Miller index symbols except that the third index is always made unity.

$$\left\{\frac{h}{l}\cdot\frac{k}{l}\cdot\frac{l}{l}(=1)\right\}$$

The zonal relations of the faces are also well exhibited in the gnomonic projection, tautozonal planes being projected in a straight line. A disadvantage of this projection consists in the fact that the prism faces, being normal to the plane of projection, are projected to infinity ($\rho = 90$, $d = tg\,\rho = \infty$). But their relative positions are given adequately by their angles $\phi$.

When the projection is carried out with care the results obtained for axial elements by measurements taken from it are very accurate, often agreeing with calculated results to the second or third decimal place.

The calculations are simple and may be carried on simultaneously with the projection, the two serving as mutual checks against errors. The form of the measurements enables all good faces of the crystal to be employed in the final determination of the crystal elements, a notable advantage over the older method which is dependent for these values on the perfection of one or two zones.

For an example of the form in which the discussion and computation of measurements taken on the goniometer with two circles may be best carried out, the reader is referred to a paper by Prof. Goldschmidt, Phosgenit von Monteponi, Zeit. für Kryst., xxi, 1893, p. 321. The compactness and simplicity of the whole is there made manifest. The use of spherical trigonometry is dispensed with and the whole computation is constantly before the eye, so that the detection of errors, if such occur, is comparatively easy.

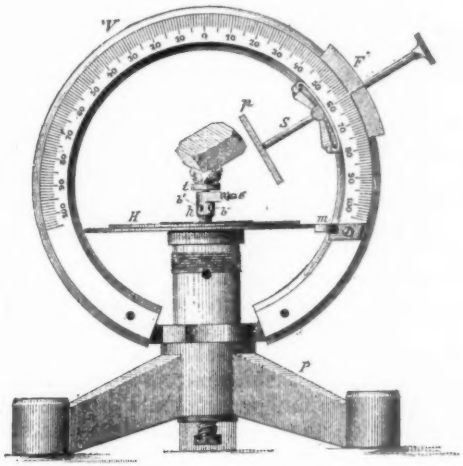
The gnomonic projection serves further as a basis for the construction of other projections. By a simple construction*

* Goldschmidt, Ueber Projection und graphische Krystallberechnung, Berlin, 1887, p. 38.

the stereographic projection may be derived from it with an accuracy not attainable by direct construction. The orthographic and clinographic projections may also be directly obtained from the gnomonic projection,* whereby the construction of the linear projection and the projection of axes is dispensed with.

Twin crystals are treated exactly as are simple ones both in measurement and projection, the position of the twinning plane, if not already known, being determinable from the projection and the perspective figure being derived as in the case of single individuals.

5.




This principle of crystal measurement has also been applied in a *contact goniometer*. This instrument is shown in fig. 5. The crystal is borne on the horizontal circle which takes the place of the vertical circle in the reflecting goniometer. The horizontal circle H revolves with the crystal and its position is read from the graduated edge.

The vertical circle V is fixed at right angles to H and in the plane of its center. It is graduated from the top in either direction from 0° to 100°. On V slides a closely-fitting carrier which holds a steel rod, S, arranged to slide in and out in a direction radial to V. On its end is a plate $p$, normal to its extension, with which contact is made with the surface to be measured.

The crystal is mounted on a support which is attached to H

* Idem, p. 82, and Ueber Krystallzeichnen, Zeitschr. f. Kryst., xix, 1891, p. 352.

by a tightly-fitting ball-and-socket joint, adjustable by a key which fits in two holes bored in the stem at right angles to each other. The crystal is affixed to the support as nearly as may be in the desired position. The prism zone, if present, is preferably placed perpendicular to H or the basal plane (pole face) parallel to H. If the basal plane is present, the carrier with S is placed at 0° and the plate $p$ brought nearly in contact with the crystal face. The crystal is then tipped gently by means of the key and ball-and-socket joint first in one direction and then at 90° to the first, until the face is parallel with $p$, that is normal to S.

If the prism zone is to be used in orienting the crystal, the rod is set at 90° and two of the prism faces successively brought parallel to $p$. In other cases the procedure is similar to that for the reflecting goniometer,* V and H in the two instruments being always interchanged. The crystal being oriented, the measurement is effected by bringing each face parallel to $p$ by movements of H and of the carrier on V. Readings are taken on each circle, that on H giving $\phi_1 = \phi - \phi_0$ where $\phi_0$ is the reading for the first meridian and that on V giving directly the polar elevation $\rho_1$. The measurements are discussed in the same manner as those on the reflecting instrument. Readings are exact to within $\frac{1}{2}°$, depending on the size and character of the faces and the practice of the observer.

The instrument is also useful in demonstrating the principle of the method, its relation to the geographical and astronomical methods of measurements, and especially the relations existing between crystal faces, their normals and their projections either in steorographic or gnomonic projection.†

A further extension and application of this method of crystal measurement is found in the latest product of Prof. Goldschmidt's inventive genius—the *projection goniometer*. The purpose of this instrument is to construct a gnomonic projection directly from the crystal without either measurement of angles or calculation being necessary. Angular measurements may, however, be taken at the same time, and the instrument thus in a measure supplies the place of the reflecting goniometer.

Fig. 6 shows the instrument as first constructed. The horizontal circle H turning about the axis A, has a plane surface of brass or glass. A paper is fastened upon it to receive the points of projection. H is graduated with readings to 1′.

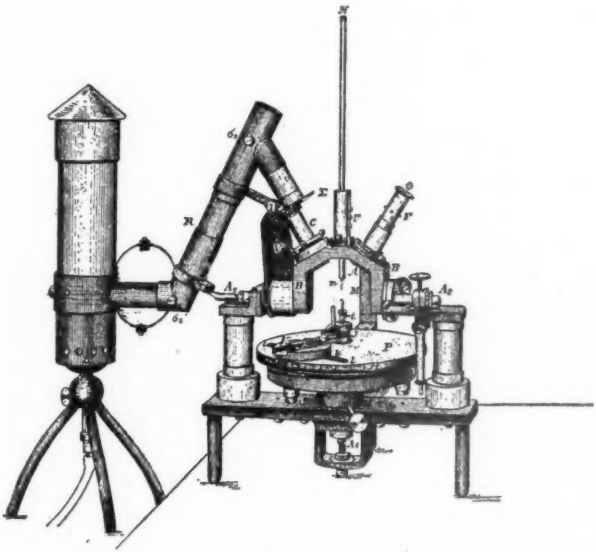
Resting freely on H is the carrier S, upon which is placed the crystal. S consists of a heavy base K; of a guide *ll*, which rests against two pegs in H and serves to keep the carrier in a

* Polarstellen am zweikreis. Goniometer, Zeitschr. für Kryst, 1895, xxiv, p. 610.

† For further details concerning the use of this instrument see Anlegegoniometer mit zwei Kreisen, V. Goldschmidt, Zeitschr. für Kryst, xxv, 1895, p. 321.

certain part of the horizontal circle; and of the centering and adjusting devices. The centering device enables the movement of the crystal in three rectangular directions, by means of which it may be brought into the intersection of the two axes $A_1$ and $A_2$. The adjusting device is a ball-and-socket joint like that of the contact goniometer, or an ordinary tipping table.

6.



The vertical circle is represented by the bent arm B revolving about the axis $A_2$ in a plane perpendicular to H. It can be clamped at any point and carries a graduated segment of a circle, V. The arm B carries the collimator C and the telescope F; and between them, in their plane and bisecting their angle CF, a rod N with needle point *n*. N can be shoved down in its bearing until the point reaches the paper, where it marks the point of projection.

The light is carried to the collimator from the lamp* by means of the broken tube R, in which are two mirrors; in all positions of the arm B the light follows the collimator. The needle N moves with the arm B about the axis $A_2$ and in a plane normal to H. Its arc is 90°, from vertical to horizontal, and the point is always directed to the same side. On this

* For the construction of this lamp see Zeitschr. für Kryst., 1894, xxii, p. 149. It employs the Welsbach light, gives an intense light for the signal and has a side opening with mirror which gives light for reading the vernier and entering notes. It is made by P. Stoë.

side at the edge of H is fixed a vertical scale M, which receives projections as of prisms and steep pyramids which would fall outside the paper. By means of a ruler at the foot of M a mark is made on the paper showing the direction of such projections (the meridian).

The use of the instrument is ordered as follows: Paper being mounted on the horizontal circle and the crystal attached to the carriage in as near the desired position as possible, the carriage is brought upon H and the crystal brought to the center of the instrument. The adjustment of the crystal in polar position is similar to the method explained for the other instruments. If the polar face is present, the vertical circle is set at 0° and the crystal tipped by means of the adjusting key until the image reflected from the face is at the crosshairs of the telescope and remains stationary during a revolution of H. If the adjustment is to be made by means of the prism zone, V is clamped at 90° and the adjustment made for two adjacent faces of the zone successively.

The crystal being oriented, V is brought to 0°, the crystal removed on its carriage and the needle is pressed down to mark the projection of the pole on the paper. The needle being withdrawn and the carriage replaced, a new face is brought to reflection by movements of H and V, both are clamped, the crystal removed as before, the point of projection pierced on the paper and readings taken on H and V for $\phi$ and $\rho$. This process is repeated for each face, is rapid and involves no special difficulties.

All the faces having been projected, the paper is removed from the instrument and mounted on a large sheet for the purpose of plotting the points which fell without its surface. The resulting projection is discussed in the same manner as the ordinary gnomonic projection. For further details concerning the use of this novel instrument, the discussion of the resulting projection, and for examples of measurements carried out upon it showing the remarkable accuracy of the results obtained, the reader is referred to the paper by Prof. Goldschmidt. Ein Projectionsgoniometer, Zeit. für Kryst., xxv, 1896, p. 538.

It is beyond the scope of this paper to describe the system of form development based on "force symbols," with its new elements and symbols, which has been developed by Prof. Goldschmidt. With the Index der Krystallformen, the forthcoming table of angular coördinates (Winkeltabelle) for all minerals, and the goniometer with two circles which is its logical outgrowth, it forms a symmetrical system destined to vastly simplify the work of practical crystallography and to increase its scope and accuracy.

Mineralogical Laboratory, Harvard University, May, 1896.

## Art. XLII.—*Search for Solar X-Rays on Pike's Peak;* by Florian Cajori.

Experiments carried on by M. C. Lea* and others have failed to show the presence of Röntgen rays in solar radiation. If these rays reach us from the sun, their intensity must be exceedingly feeble. The suggestion has been made that Röntgen rays may exist in sun-light, but are absorbed by the earth's atmosphere. The fact that Lenard rays are stopped by only a thin layer of air made it not improbable that Röntgen rays might be stopped by a thick layer of it. On this hypothesis a mountain top is the best locality to examine sun-light for the new rays. The writer determined, moreover, to expose the photographic plate to solar rays, not several hours, but several weeks.

During preliminary experiments made in Colorado Springs, it was found that a sheet of aluminium would allow certain solar rays to pass through. These were not Röntgen rays, for the reason that black paper placed between the aluminium and the photographic plate seemed to cast as deep a shadow as did a strip of iron. A different mode of exposing the plate was necessary and a plan similar to Lea's was finally adopted.

The first 100 leaves of an unbound book were turned over, and a rectangular trough of the dimensions of the photographic plate (7·5 by 13$^{cm}$) cut into the next 55 pages. Seven pages above this trough, thin metallic plates, from 5 to 20$^{mm}$ wide, were placed between two leaves and held in position by gumming the two leaves together. Care was taken to let the mucilage dry before shutting the book. After the photographic plate (Seed, 23) was placed in the trough, the book was closed, wrapped in black tissue paper, then in paraffine paper, and finally put into a tin box.

The box was prepared as follows: Its lid was placed externally over its bottom and a rectangular window, 7·5 by 13·5$^{cm}$, cut through them both. Thereupon a sheet of aluminium, 13 by 23$^{cm}$, and ·29$^{mm}$ thick, was placed between the lid and the bottom, so as to screen the window. The wide margin of the aluminium, lying between the sheets of tin, was united to them above and below by thin layers of bees'-wax. Externally the edges of the rectangular window were covered with sealing-wax, to which a thick layer of paint was finally applied. A new lid was provided for the open side of the box and both lids were soldered on. Prepared in this manner, the box could be left exposed to all kinds of weather without danger that moisture would reach the photographic plate. To touch the

* This Journal, IV, vol. i, May, 1896, pp. 363, 364.

plate, rays had to penetrate the sheet of aluminium, a few layers of paraffine and black paper, and 100 pages of the book. Röntgen rays of intensity ordinarily met with in the laboratory penetrate at once very much greater thicknesses of these materials.

Through the kindness of Mr. F. Blackmer and Mr. D. Rupp, of Colorado Springs, the box was taken to the summit of Pike's Peak (elevation 14,147 ft.) and fastened by wires upon a roof sloping southward. The box was left in that position from June 27 to August 10. When subjected to the usual process of development, the plate failed to show any action of rays and presented a uniform surface, without traces of shadows from the metallic strips. Another plate, similarly exposed from July 7 to August 28 in Rosamont Park, near Pike's Peak, at an altitude of 9200 ft., gave the same result.

Thus even in high altitudes no evidence of the presence of Röntgen rays in solar radiation was obtained.

Colorado College, Colorado Springs.

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ART. XLIII.—*Note on recently discovered Dikes of Alnoite at Manheim, N. Y.;* by C. H. SMYTH, JR.

THE occurrence of alnoite at Manheim, N. Y., is of interest both on account of the rarity of the rock, and because it is one of several rather widely-scattered occurrences of basic intrusions cutting the Paleozoic rocks of Central New York.

When described by the writer,* some years since, the rock was represented, so far as known, by a single dike, of very limited dimensions. Recent blasting in the stream gorge, a few rods above the old locality, has exposed another dike, and a third one of small size has been found near by. The latter dike is precisely like the small one previously described, but not so well exposed, as it lies in a very irregular fissure, from which it has been deeply weathered out, the resulting excavation being nearly filled with bowlders washed in by the stream.

A similar fissure, but much larger, formerly existed where the blasting has been done, and is now clearly seen to have been formed by the weathering of a dike about six feet in width. The rock of this dike bears a general resemblance to that of the smaller dikes, but shows some decided variations resulting from the greater size of the intrusion. At and near the contact with the surrounding Calciferous, it shows small phenocrysts in a very fine-grained groundmass. Toward the center, however, it becomes quite coarse and inclined to granu-

* This Journal, III, xliii, p. 322, and xlvi, p. 104.

lar, showing an abundance of mica. The structure in these central portions has been considerably modified by shearing, the rock being crushed, slickensided and much altered. Unfortunately, this has rendered it difficult to procure satisfactory material for study from the coarser parts of the rock.

A notable feature of the dike is the presence in it of long, narrow "horses" of the country rock. One of these is fifteen or twenty feet long, about one foot wide, and with tapering ends. These horses affect the dike just as the walls do, rendering the rock fine-grained. The rock of the walls and horses shows very scanty signs of contact metamorphism, consisting of some slight changes of color.

The color of the fresh dike rock is very dark-gray to black; but there is often a tinge of green from alteration and this is sometimes pronounced. Further decomposition breaks the rock down to a sandy clay with scattered flakes of mica. Under the microscope, this clay is seen to consist chiefly of finely-divided mica, with minor magnetite and apatite, the other minerals having disappeared. That such complete alteration and disintegration take place readily is shown by the occurrence of the dikes in deeply excavated trenches. It is also perfectly displayed on the opposite side of the stream, where what is doubtless the continuation of the large dike is shown. It is a vertical band of the clay above described, cutting sharply through the Calciferous, and exposed for a height of about twenty feet. The wall rock is perfectly fresh, but the dike is so thoroughly decomposed that only the scales of mica and an occasional lump of alnoite the size of a walnut show the true origin of the material.

Sections of the rock of the small dike agree perfectly with the original dike, and need no further consideration. The large dike, however, shows decided differences, with one exception, of such a nature as would be expected from its coarser structure.

Sections of specimens taken from near the margins of the dike, or close to the included horses, have a very fine groundmass, in some cases looking almost like an altered glass. In this are scattered phenocrysts of deep-brown mica and altered olivin. The latter mineral, in these parts of the dike, is usually represented by a semi-opaque, white substance, through which is disseminated a black dust, doubtless magnetite. This method of alteration of olivine seems to be dependent upon proximity to the wall rock, as it does not appear in the central portions of the dike.

Sections from the latter approach a granular structure, and consist chiefly of mica and altered olivine. The structure is not that of a granite-granular or hypidiomorphic rock, as the two chief minerals are quite commonly bounded by their true crystal form. The mica has a deep reddish-brown color, is

strongly pleochroic and in basal sections often has a marked zonal structure. In spite of the fresh look of the rock in hand specimens (which is due to the great abundance of mica), not a grain of unchanged olivine has been found, and the determination of the mineral is based wholly upon the form and composition of the alteration product, and the undoubted presence of olivine in the neighboring dikes. It is now represented by serpentine of deep green color. Less often a phenocryst is clear and colorless, presenting at first glance the appearance of unchanged olivine, but, with crossed nicols, showing aggregate polarization in low tints.

In addition to the two chief constituents, magnetite and apatite are present in some quantity, while perofskite is less abundant. Large amounts of secondary calcite are shown in nearly every section.

The most striking feature of the rock is the scarcity or absence of melilite. In the other two dikes this mineral is abundant, though often greatly altered; but in the large dike it has not been positively identified, although its presence is occasionally indicated by obscure alteration products.

This peculiar fact admits of two explanations. It is possible that, owing to the slow crystallization of the material of the large dike, or to some other variation of conditions, melilite was never formed, its elements entering into other combinations. If this were so, hornblende or pyroxene might be expected in the rock, and none is shown. It is possible, however, that such a mineral is now represented by a part of the serpentinous alteration products.

The second explanation of the absence of melilite ascribes it to the complete removal of the mineral by the processes of alteration. This supposition is in harmony with the well-known susceptibility of the mineral to alteration, which is well shown in the other dikes, where much of the melilite is so altered as to entirely obscure its original properties. Nevertheless, even here, much clearer traces of its form and structure may be seen than in the large dike, where they are usually absent.

Between these two explanations it is impossible to decide with absolute certainty. But in view of the close proximity of the three dikes, the similarity of conditions that must have prevailed during their consolidation, and the identity of all the other minerals, together with the excessive alteration of the large dike, it seems extremely probable that melilite was originally present in the latter. On this ground it is included with the other two dikes under the term alnoite.

That still other dikes of a similar character exist in the vicinity can hardly be doubted, but their extreme susceptibility to weathering combines with the extensive covering of glacial material to conceal them from observation.

Hamilton College, Clinton, N. Y., June, 1896.

ART. XLIV.—*The Action of Ferric Chloride on Metallic Gold;* by PARKER C. MCILHINEY, Ph.D.

IN the course of a number of experiments on the solubility of gold the action of pure concentrated hydrochloric acid on precipitated gold was tried by placing the two together in glass tubes, which were then sealed up and heated to about 150° C. for varying lengths of time. In one of the tubes considerable gold was found to have been dissolved, while in others none was dissolved, and investigation showed that the gold which had gone into solution was contaminated with a trace of iron. The experiment was repeated, using 0·046 gram of the same gold and 10$^{cc}$ of hydrochloric acid. After heating, the gold was found completely dissolved and on separating the gold from the solution by $H_2S$ and determining the iron in the filtrate 0·0008 $Fe_2O_3$ was found, about $\frac{1}{57}$ the amount of gold. Schild* states that ferric chloride attacks gold with formation of ferrous and auric chlorides. Napier† and Comey‡ state that ferric chloride dissolves gold, and Comey states that it is dissolved by hydrochloric acid containing ferric chloride.

In view of the fact that ferrous salts precipitate gold from solution very perfectly, it seems remarkable that the reaction given by Schild could take place to such an extent as to dissolve a weighable amount of gold, and in any event it would not account for the solution of fifty parts of gold by one of iron. In the experiments cited the portion of the sealed tubes not occupied by liquid was full of air, and on measuring its volume it was found that sufficient oxygen was present in it to have reacted with the hydrochloric acid and gold to produce water and gold chloride in such quantities as were found in solution, providing that the small amount of ferric chloride was assumed to act as a carrier of chlorine from the hydrochloric acid to the gold. In order to ascertain definitely that it was the iron and not some other undiscovered impurity which had caused the gold to dissolve, a quantity of gold was obtained which had been purified at the New York Assay Office six times by solution, precipitation and fusion. Some of this gold was dissolved in aqua regia, precipitated with oxalic acid and washed for a long time by decantation with distilled water. 0·500 gram of this precipitated gold was placed in a tube with 10$^{cc}$ hydrochloric acid and 0·0002 gram ferric chloride and the tube sealed without removing the air. Another tube was prepared containing the same

* Berg. u. Hüttenm. Ztg., xlvii, 251. † Phil. Mag., 1844, iii, xxiv, 370.
‡ Dict. Sol., 172.

amount of gold and acid but twelve times as much ferric chloride, and this tube was boiled for several minutes before sealing and sealed while still boiling in order to remove the air. After heating the tubes the liquid in the first was found to contain 0·0109 gold in solution, while in the liquid in the second tube a slight test for gold could be obtained only with difficulty, and it seemed likely that this small amount of gold might have been dissolved before the tube was boiled and after the materials had been added. Another small tube was prepared containing about a gram of ferric chloride dissolved in concentrated hydrochloric acid and the tube boiled to expel air and sealed while boiling. This tube was placed in a larger tube containing concentrated hydrochloric acid and 0·500 gram gold and the liquid in the larger tube also boiled for some minutes and sealed boiling. The smaller tube was then broken by shaking, allowing the iron to mix with the acid and come in contact with the gold without access of air. This tube was then heated as the others had been and the liquid tested for dissolved gold. Not a trace was to be found.

It thus appears that hydrochloric acid in presence of air is without action on metallic gold, that ferric chloride is without action on gold unless oxygen is present, but that ferric chloride acts as a very efficient carrier of chlorine in the presence of hydrochloric acid and oxygen. This fact helps to account for the solubility of gold in mine waters and in other waters containing iron, acid, and common salt.

Metallurgical Laboratory, Columbia University, N. Y.

ART. XLV.—*The Geology of Block Island;* by O. C. MARSH.

A RECENT visit to Block Island gave me an opportunity to examine its geological structure, and this proved much more interesting than the published accounts had led me to expect. I had previously seen this island only from a distance, yet I supposed from what I had read that it contained none of the older rocks in place, but was a remnant of the great terminal moraine that, in the glacial period, was pushed over from the main land of southern New England, and left its debris as Long Island and the other islands to the eastward.* That Block Island was once connected with Long Island is suggested by a glance at a map of the New England coast, and that the same great moraine extended over both is equally evident from facts well known. An examination of Block Island itself, however, soon proved to me that these glacial deposits were merely a superficial covering, while the main body of the island was formed of much older beds, the exact age of which offers a most interesting problem.

These lower strata consist mainly of massive beds of clay, more or less arenaceous, and all considerably disturbed. The general inclination is to the northeast, as is well shown in the fine sections exposed on the coast, especially in the bluffs on the east and south of the island, which are rapidly wearing away from the assaults of Atlantic waves. Some of these clays are white in color, as seen in the cliffs at Clay Head, on the northeast shore of the island. Some bright-red clays also occur near the water's edge at low tide, at the foot of the same bluff, but the most of these deposits are gray or brown in color. At a few points, where carbonaceous matters have discolored them, they are nearly or quite black, and in such places, specimens of fossil wood and other plant remains are comparatively abundant. One locality of this character may be seen in a bluff on the southeast shore, a short distance west of the Ocean View hotel. Another marked character of these clay cliffs is the deposits of iron they contain. This ore is mainly limonite, usually in thin seams, and its decomposition has stained the layers in many places a rusty color, which frequently serves to indicate the dip of the strata. Iron pyrites occurs in the dark clays with the plant remains.

These massive beds of clay, with their characteristic features, are well shown in all the high cliffs of the coast that are being rapidly eroded by the ocean storms. The famous Mohegan

*Seventh Annual Report U. S. Geol. Survey, p. 304, 1888; and Bulletin U. S. Geol. Survey, No. 53, p. 11, 1889.

Bluffs, on the southeast shore of the island, afford a fine example of this, as here the clays show a vertical thickness of about a hundred and fifty feet. Judging by the inclination of the beds, which are highly inclined, a great thickness of strata is here represented. This fact, together with the disturbance they have undergone, is an important element in the problem of their age, and indicates for them a much greater antiquity than would otherwise be supposed from the nature of the deposits themselves.

These foundation clays of Block Island were evidently much eroded before the glacial drift was spread over them. They still constitute the bulk of the island, and their depressions form an impervious stratum for the bottom of the numerous ponds for which the island is renowned. These clays all appear to be fresh-water deposits, and should certainly contain vertebrate fossils. I found none in the limited time at my command, but more careful exploration would undoubtedly bring them to light, and thus determine the geological age of these interesting beds. In the mean time, a comparison of various deposits at some other points on the coast may, perhaps, suggest a solution of this problem.

In exploring the Tertiary and Cretaceous strata of the Atlantic coast south of New York, I have had much experience, but know of nothing in these two formations there exposed that offers a parallel to the deposits now under discussion. The still older Potomac beds, however, have many similar features, and to this horizon I should be inclined, on present evidence, to refer the greater portion, at least, of the Block Island clays. From the Potomac formation in Maryland, I have secured a large collection of fossil vertebrates that indicate a period corresponding nearly to the Wealden of England, which is now regarded by the best authorities as late Jurassic, and to this age the vertebrate fossils of the Potomac may likewise be assigned.* The special horizon in which these vertebrates are most abundant in Maryland may be called the Pleurocœlus beds, from a genus of Dinosaurs found there, especially in the iron-ore clays, which are similar in physical characters to some on Block Island.

The Raritan clays of New Jersey, I regard as belonging to the same series as the Potomac beds, since they hold the same relative position stratigraphically, while the only vertebrate fossils thus far reported from them (remains of a Dinosaur and a Plesiosaur, both preserved in the Yale Museum) also tend, in part, to confirm this view. The latter is probably from a higher horizon.

* This Journal, vol. xxxv, p. 90, 1888. See, also, Sixteenth Annual Report U. S. Geol. Survey, Part I, p. 183, 1896.

The well known clay deposits of Long Island I have not carefully examined in place. There is much in the published descriptions of them, however, to indicate that they may represent some of the same Jurassic beds. Near the eastern end of the island, there are beds of clay closely resembling some on Block Island.

The clay bluffs at Gay Head, on Martha's Vineyard, have many characteristics of the same series, but the presence of Cetacean remains in one portion of them indicates that this is Tertiary. There are, however, some reasons for supposing that the most of the clays are much older, and I believe they contain representatives of the same great Jurassic formation. Some of the vertebrate remains from Gay Head, described as Reptilian (*Graphiodon*), I found on examination to be Cetacean, and it is possible that others, now regarded as Cetacean, may prove to be Dinosaurian, as was the case with some Potomac fossils.

The massive clay beds of Block Island were derived from the decomposition of the granitic rocks to the north, and were deposited in quiet waters. The iron ore now in them came also from the northern crystalline rocks mainly as magnetite, which may still be seen in the sands of all the beaches of the island, and on one of them this mineral sand was for a while used in making metallic iron.

There appear to be no crystalline rocks in place on the island, although some of the large imbedded boulders might readily suggest such outcrops. The glacial drift covers most of the surface, and the hills and shores are strewn with boulders of crystalline rocks,—granite, gneiss, quartz, etc., that came over the ice from the main land on the north. Large masses of both the porphyritic and the garnet-bearing gneiss, waifs from the Rhode Island shore, may be easily recognized, and in the beach sand resulting from the attrition of the latter, the separate garnets may be found.

On some of the glacial hills near the shore, or around the Great Pond, shell heaps of considerable antiquity may be observed, but so far as I could ascertain, none of them have been explored. One may be seen on the south side of the road recently cut through a low hill, near the new steamboat landing on Great Pond. The deposits are several feet in thickness, indicating a long occupancy of the place by some of the early inhabitants of the island. The short examination I was able to give this "kitchen midden" disclosed many marine shells, mainly species now living in the adjacent waters, the most abundant of which were those of oysters, clams, and scollops. Mingled with these were a few bones of fishes, birds, and small mammals.

The presence of such great masses of stratified clay, evidently of high antiquity, on this diminutive island facing the Atlantic, opens up many questions of interest beyond the mere geological age of the deposits. These beds of clay must be the remnants of a great formation, which extended out far beyond the present coast line, and being of fresh-water origin and laid down in quiet waters, they prove the former existence of an extensive barrier along the continental border between them and the Atlantic depths beyond.

It has long been a reproach to American geologists that they could find no true Jurassic on the Atlantic coast, although the next formations above and below are well developed at many points. May not the missing strata be represented in the characteristic series of Block Island clays? The evidence as it stands to-day points to this conclusion.

New Haven, Conn., September 5, 1896.

*Postscript.*

Since the above was in print, I have visited Long Island and Martha's Vineyard to ascertain if the Block Island clays are represented there, as they should be if my conclusions are correct. On Martha's Vineyard, I found that the great series of variegated clays forming Gay Head, and generally regarded as Tertiary, are certainly Mesozoic, and all apparently Jurassic. They have the same general features as the Block Island clays, but are more highly colored, and have been more disturbed. They, also, suffered much from denudation before the Glacial period.

Prior to that period, however, they were covered by a series of marine Miocene deposits, remnants of which still rest unconformably upon them. The vertebrate fossils reported from Gay Head were apparently all from this horizon, which also contains many mollusks.

The cliffs of Gay Head are rapidly washing into the sea, the base being first undermined by storms, causing very extensive landslides which have led to much confusion in regard to the natural position and mutual relations of the various strata.

On Long Island, I visited a number of localities, including Montauk Point, where there are clay beds similar to those on Block Island, although possibly of somewhat later date. Other preglacial freshwater clays at various points on the north shore appear to be of the same age as those at Gay Head. I hope soon to discuss this subject more fully elsewhere.

New Haven, Conn., September 21, 1896.

## SCIENTIFIC INTELLIGENCE.

### I. Chemistry and Physics.

1. *An Empirical Relation between Melting-point and Critical Temperature.*—F. W. Clarke calls attention to a remarkable relation which appears to exist between the two constants under consideration. The data are very meager, but the author has been able to examine the ratio in the case of about thirty substances.

In nine cases the absolute melting point is nearly, if not exactly one-half the absolute critical temperature, that is, *the thermometric lengths for the solid and liquid states are equal.* The following table gives the data in these cases, where $t$ is the melting-point, T the critical temperature, and the ratio that of the absolute temperatures, $\frac{T+273^\circ}{t+273^\circ}$.

| | $t$ degrees | T degrees. | Ratio. |
|---|---|---|---|
| Nitrogen | −214·0 | −146·0 | 2·18 |
| Carbonic oxide | −207·0 | −139·5 | 2·02 |
| Argon | −190·0 | −121·0 | 1·83 |
| Methane | −186·0 | −82·0 | 2·19 |
| Hydrochloric acid | −112·5 | + 52·0 | 2·02 |
| Hydrogen sulphide | − 86·0 | +100·0 | 2·00 |
| Ammonia | − 75·0 | +130·0 | 2·03 |
| Benzene | + 3·0 | +288·5 | 2·04 |
| Acetic acid | + 17·5 | +322·0 | 2·05 |

This simple relation, however, is not general, but there are other marked regularities among related compounds. The following gaseous compounds of nitrogen give closely agreeing results:

| | $t$ degrees. | T degrees. | Ratio. |
|---|---|---|---|
| $C_2N_2$ | − 34·5 | +124·0 | 1·67 |
| $N_2O_4$ | − 10·0 | +171·0 | 1·64 |
| NO | −167·8 | − 93·5 | 1·70 |
| $N_2O$ | − 99·0 | + 35·5 | 1·77 |

Five aromatic bodies give:

| | $t$ degrees. | T degrees. | Ratio. |
|---|---|---|---|
| *o*-Xylene | −45·0 | +358·0 | 2·77 |
| *m*-Xylene | −53·0 | +346·0 | 2·81 |
| $C_6H_5Cl$ | −40·0 | +361·0 | 2·78 |
| $C_6H_5Br$ | −30·5 | +397·0 | 2·75 |
| $C_6H_5I$ | −28·5 | +448·0 | 2·94 |

For most of the other substances the ratios range between 2·2 and 3·0, thus:

| | | | |
|---|---|---|---|
| $Br_2$ | 2·17 | $H_2O$ | 2·34 |
| $Cl_2$ | 2·44 | $SnCl_4$ | 2·47 |
| $SO_2$ | 2·22 | $CHCl_3$ | 2·62 |
| $CCl_4$ | 2·25 | $C_2H_4$ | 2·75 |

The value for carbon dioxide is only 1·41, while a few bodies give ratios higher than three, ether 3·06, $CS_2$ 3·36, $PCl_3$ 3·47, alcohol 3·59.

The author offers no explanation of these ratios, but believes that they are not meaningless.—*Am. Chem. Journal*, xviii, 618.

H. L. W.

2. *The Quantitative Separation of Chlorine, Bromine and Iodine.*—Bennett and Placeway have applied the qualitative method, described by Prof. Edward Hart a number of years ago, to the quantitative separation of the halogens with satisfactory results. The method recommended is briefly as follows: To a solution of the alkali salts in a distilling-flask, a solution of $10^g$ of ammonium ferric alum is added with water enough to make a total volume of about $200^{cc}$, and the mixture is distilled for about 25 minutes. The iodine is absorbed in a receiver with a solution of potassium iodide and titrated with sodium thiosulphate. To determine bromine, $35^{cc}$ of a saturated solution of potassium permanganate are added to the residue in the distilling-flask, water is added to make the volume $200^{cc}$ as at first, and a distillation is made exactly as in the previous case. Chlorine can be determined in an aliquot part of the final residue in the distilling-flask either by a volumetric or a gravimetric method.—*Jour. Am. Chem. Soc.*, xviii, 688.

H. L. W.

3. *The homogeneity of Argon and of Helium.*—Ramsay and Collie have studied this interesting question by submitting the two gases to systematic diffusion, dividing each gas into two parts by a method analogous to fractional distillation. The gases were caused to traverse a duct of porous pipe-clay, submitted on one of its surfaces to the action of a vacuum. The authors satisfied themselves that the separation of hydrogen and helium and that of oxygen and carbonic acid could be effected in this way, and that, by measuring the descent of a column of mercury connected with the apparatus, it is possible to arrive at a good determination of the molecular weight of various gases.

When argon was submitted to this fractionation, the two extreme portions had densities of 19·93 and 20·01. The separation, if any, in this case was very slight.

With helium the results were different. A more diffusible part with a density of 1·874 was obtained, while, at the other end, the gas had a density of 2·133. A great number of further fractionations did not change these densities. The two fractions, however, showed absolutely identical spectra. Considering what happens when a mixture of two gases is diffused, as, for example,

when a mixture of an excess of oxygen with hydrogen is sufficiently fractionated, pure oxygen is obtained on the one hand, while on the other hand a mixture of one part of hydrogen with four parts of oxygen diffuses unchanged, the authors have calculated that if helium consists of a mixture, it is composed either of two gases of the densities 2·366 and 1·874 or of two with the densities 2·133 and 1·580.

The authors finally mention what they consider a possible explanation of this behavior of helium, in that the heavy molecules may have been separated from lighter molecules of the *same gas*. They state that the idea that all the molecules of a gas are homogeneous has never been submitted to the test of experiment, and they believe that this question deserves further study.—*Comptes Rendus*, cxxiii, 214. H. L. W.

4. *Argon and Helium from a Natural Spring.*—Ch. Moureu has examined the gas from a spring at Maizières (Côte-d'Or), and has found it to contain a small quantity of oxygen, about 2 per cent, the remainder showing the negative characters of nitrogen. After the absorption of nitrogen by metallic lithium, a remarkably large residue remained, amounting to between $\frac{1}{15}$ and $\frac{1}{10}$ of the total volume, giving the characteristic spectrum lines of argon and helium.—*Bull. Soc. Chim.*, xv, 626. H. L. W.

5. *The liquefaction of helium.*—Olszewski, working upon a sample of helium gas obtained by Ramsay from the mineral cleveite, has found that it remains permanent even under the most extreme conditions as to temperature and pressure available. In one series of experiments the helium, confined under a pressure of 125 atmospheres, was cooled to the temperature of oxygen, boiling first under atmospheric pressure (−182°·5) and then under a pressure of $10^{mm}$ of mercury (−210°). In neither case did it condense, nor was there any indication of liquefaction even when the gas was expanded till the pressure fell to one atmosphere. In the second series of experiments liquid air boiling at $10^{mm}$ of mercury (about −220°) was employed, the helium being under a pressure of 140 atmospheres; but here also the results were negative. Theoretical calculations, based upon the formula of Laplace and Poisson for change of temperature under adiabatic expansion, led to the conclusion that the boiling point of helium lies below −264°, or at least 20° lower than the values obtained by Olszewski for hydrogen. The higher density of helium, however, would lead one to expect that the boiling point would also be above that of hydrogen.—*Nature*, liv, 377.

## II. Geology and Mineralogy.

1. *Glacial deposits, preglacial valleys, and interglacial lake-formation in Subalpine Switzerland.*—Dr. C. S. Du Riche Preller read an interesting paper with the above title before the Geological Society of London in May last. The conclusions he reached after a careful examination of the evidence, particu-

larly in the Zurich valley and its neighborhood, appear to be well established. As they differ from the usual interpretation of the phenomena, their reproduction here will call the attention of our readers to their importance.

"It will be observed that the conclusions at which I have arrived in this paper differ in some respects widely from the views recently enunciated by several Swiss geologists. More especially does this difference relate to the question whether the principal Subalpine valleys were excavated before or after the first or Upper Pliocene glaciation.

Apart from the evidence I have adduced, my conclusion that the first glaciation found the principal Subalpine valleys already eroded derives substantial support from the very history of the Tertiary epoch. In Eocene times the Alps had already emerged from the surrounding sea, though as yet only as a group of low islands. The Miocene period witnessed the principal thrusting and folding of the Jura and the Alps: and the products of increased denudation—namely, sand and clay, afterwards hardened to Molasse, and fluviatile detritus subsequently cemented to compact conglomerate—were deposited between the two ranges in two freshwater and one intermediate marine series, the latter being formed in an arm of the sea which, towards the end of the Miocene period, still reached from the Mayence basin to the foot of the Alps. The process of folding continuing, the Subalpine Molasse and the enormous banks of conglomerate, too, were raised, notably near the Alps; the sea receded; the lakes formed in the shallow depressions of the Molasse plateau dried up, and, consequent upon the increased steepness of the Alpine slopes, denudation and erosion set in on a greatly enhanced scale; rapids and ravines formed; the great Alpine rivers effected in the Miocene Nagelfluh walls those breaches which later on afforded easy and convenient passages to glaciers; and broad valleys were eroded in the soft Molasse strata of the Swiss lowlands, the general direction of discharge being towards the natural collecting-channel along the foot of the Jura, and thence to the Rhine. Thus, the Lower and Middle Pliocene period in Subalpine Switzerland did not witness the deposition of any new rock-formations, but was an unbroken period of erosion and denudation on a prodigious scale. The long duration of this post-Miocene and pre-Glacial period appears the more obvious when we reflect that it was contemporaneous with the formation of the extensive marine beds of the Subapennine hills and of Sicily.

It is a singular fact that the geological epoch which immediately preceded the appearance of man is perhaps the most difficult to unravel. But unless we assume that in this post-Miocene and pre-Glacial period, which Sir Charles Lyell regarded as of incalculable duration, the work of Nature stood still, we are driven to the conclusion that, at the advent of the first Ice-period in Upper Pliocene times, the principal Subalpine valleys were already excavated approximately to their present depth, and that

ever since then the action of the great Alpine and Subalpine rivers has been, as it still is in our own day, mainly directed to regaining the old valley-floors by removing those enormous accumulations of glacial and glacio-fluviatile material which are respectively the direct and indirect products of three successive and general glaciations.—*Q. J. G. Soc.*, lii.

2. *U. S. Geological Survey.*—The completed volumes of Parts II, III and IV of the Sixteenth Annual Report have been issued, and notice has already appeared in our pages of the director's official report and several separate papers of Part I already published.*

Part II contains papers of an economic character. Among them are the report on the "Geology and mining industries of the Cripple Creek district, Colorado," by Whitman Cross and R. A. F. Penrose Jr. (pp. 1–210), and Mr. F. N. Newell's report on "The Public Lands and their water supply" (pp. 457–588).

Parts III and IV contain the annual report (for 1894) on the Mineral Resources of the United States, which has heretofore been published as a separate report, now appearing as two large volumes, Part III on metallic products and IV on non-metallic products. These volumes were prepared, as the earlier ones of the same series, by David T. Day, geologist in charge, with the assistance of specialists.

3. *Bibliography and Index of North American Geology, Paleontology, Petrology, and Mineralogy for 1892 and 1893;* by F. B. WEEKS. Bulletin No. 130, U. S. Geological Survey. —This Bulletin is a continuation of the annual publication heretofore known as the "Record of North American Geology" (Bulletins Nos. 44, 75, 91, 99). The extended scope of the work necessitated a change in its arrangement. It is divided into two parts; a bibliography and a subject index. The bibliography is arranged alphabetically by author's names. The index comprises geographic, geologic, mineralogic, paleontologic, and petrologic subdivisions, arranged alphabetically; and lists of economic products, minerals, rocks, and fossils described in the various papers listed in the bibliography are given. A similar bibliography and index for the year 1894, and another for the year 1895 (Bulletins Nos. 135 and 146, respectively) are in press and will be delivered soon.

4. *Iowa Geological Survey.*—The Annual Report for 1895, with accompanying papers by State Geologist Samuel Calvin and Assistant H. Foster Bain, has appeared with the usual amount of new contributions in the elaboration of the geology of this state. The special reports in this volume cover the counties of Jones, Washington, Boone, Woodbury, Warren and Appanoose.

5. *Elements of Geology, a text-book for colleges and the general reader, by* JOSEPH LECONTE, *4th edition, revised and enlarged, with new plates and illustrations,* pp. 670. (D. Appleton & Co.) 1896.—This excellent text-book of geology, improved by the revision, the addition of new matter and many new figures,

* This Journal, vol. cli, pp. 142–146.

comes to us in a new edition with all the merits of the old well-attested by a wide usage in the colleges of the land. As the author set forth to do in the preface to the first edition, he has succeeded in doing: viz. the making of a work "which shall be both interesting and profitable to the intelligent general reader, and at the same time a suitable text-book for the higher classes of our colleges."

Some additions as well as changes in the arrangement have been made, the most important of which are "a fuller discussion of the difficult subject of *earthquakes*, in the light of the recent investigations of Milne, Dutton, Seebach and Schmidt; a brief account of the origin of *varieties of igneous rocks by differentiation of rock-magmas*, made necessary by the writings of Iddings and others; a greater emphasis on the *Cambrian* as a subdivision of the Palæozoic; the latest results of Walcott, Matthew, and Beecher on the *structure* and affinities of Trilobites: the latest results of Marsh, Cope, Osborn, Scott, and Wortman on the *structure and affinities of Mesozoic reptiles and Mesozoic and Tertiary mammals;* some clearer statement on the *subject of the causes of the glacial climate;* and a brief discussion of the *causes of geological climates* in general."

6. *On the amount of gold and silver in sea-water.*—Prof. A. Liversidge has carried on a series of experiments made with the object of determining the amount of gold in the sea-water off the coast of New South Wales. The method of Sonstadt (Chem. News, 1872, pp. 159, 160 and March 11, 1892) was employed. After detailing the separate experiments and remarking that the amount of gold found must necessarily be less than the total amount present in the water, the author concludes that all the "evidence is in favor of gold being present in sea-water off the New South Wales coast in the proportion of about ·5 to 1 grain per ton, or in round numbers from 130 to 260 tons of gold per cubic mile. This of course means an enormous amount for the whole of the ocean, the cubic contents of which used to be put down at 400,000,000 cubic miles, and if the gold be uniformly present at the rate of 1 grain per ton the total amount would be over 100,000,000,000 tons of gold; a later estimate is 308,710,679 cubic miles; this even would mean over 75,000,000,000 tons of gold. But at the present day it would probably not pay to extract the gold by itself, although it might as a bye-product in the manufacture of salt, bromine, etc. The enormous amount of gold in the sea is, however, probably very small in comparison with the amount scattered through sedimentary and crystallized rocks, i. e., apart from gold in veins and other deposits." He adds further that all the sea-waters gave some silver, usually from one to two grains per ton, but the scorification and cupellation process were lacking in the necessary precision for the exact determination of silver in such minute quantities as it exists in sea-water.

A subsequent article discusses the supposed removal of silver and gold from sea-water by Muntz metal sheathing. The results

of the experiments do not altogether agree with previously published views. The author finds that "the silver has not accumulated, but on the contrary decreased; the scale, however, contains a larger amount of gold. The increase of gold in the scale may be due to the deposition of gold from the sea-water on to the surface of the metal, or it may be due to the comparative non-solubility of gold in sea-water; the muntz metal having been corroded and dissolved away, together with much of the silver, leaving the gold behind." He believes that it is "probably due to both causes, i. e., partly to deposition and partly to accumulation, for the superficial parts of certain of the experimental plates obtained by scraping them, show an increase in the amount of gold and a decrease in the amount of silver; the increase in the gold cannot in these cases well be due to mere accumulation, since the plates do not appear to have lost sufficient weight to materially increase the proportion of the residual gold."

7. *Brief notices of some recently described minerals.*—RATHITE, named by Baumhauer after Gerhard vom Rath, is a new mineral from the dolomite of the Binnenthal, a region to which the honored German mineralogist devoted much study. It occurs in slender needle-like crystals belonging to the orthorhombic system; these have a prismatic development parallel to the macrodiagonal axis with fine striations and approximate to dufrenoysite in angle; they are in part twins. It resembles dufrenoysite in color and luster. An analysis by A. Bömer gave:

| S | As | Sb | Pb | Fe |
|---|---|---|---|---|
| 23·72 | 17·24 | 4·53 | 52·98 | 0·56=99·03 |

The exact formula remains in doubt.—*Zeitschr. Kryst.*, xxvi, 593, 1896.

SALVADORITE is a new copper-iron vitriol from the Salvador mine, Quatena, Chili. It occurs as a crystalline aggregate of a bluish green color. Analyses of two kinds gave:

| | $SO_3$ | CuO | FeO | $H_2O$ |
|---|---|---|---|---|
| Green | 27·87 | 18·77 | 8·49 | 44·65 = 99·78 |
| Blue | 28·16 | 17·57 | 9·59 | 44·31 = 99·63 |

For these the formula, $FeCu_2(SO_4)_3+21H_2O$ is calculated. This brings it near pisanite, from which, however, it differs in optical characters. Described by W. Herz in *Zeitschr. Kryst.*, xxvi, 16, 1896.

CASWELLITE, named after John H. Caswell of New York, is an altered biotite from Franklin Furnace, New Jersey. It has a copper-red or flesh color, resembling a light-colored clintonite; hardness 2·5–3; specific gravity 3·54. It retains the cleavage but has lost the elasticity of the original mineral. It is associated with massive yellow garnet and rhodonite. An analysis gave:

| | $SO_2$ | $Fe_2O_3$ | $Al_2O_3$ | $Mn_2O_3$ | CaO | MgO | ign. |
|---|---|---|---|---|---|---|---|
| ⅔ | 38·74 | 6·85 | 6·58 | 15·95 | 22·30 | 5·52 | 4·64=100·58 |

Described by A. H. Chester in the *Ann. Rep. State Geologist of New Jersey* for 1895.

RHODOPHOSPHITE, TETRAGOPHOSPHITE are two partially described minerals from Horrsjöberg in Wermland, Sweden, named by Igelström. Rhodophosphite varies in color from white to red; it occurs in masses, associated with lazulite, cyanite, etc. The analysis shows a small amount of $SO_3$, but the large loss makes any conclusion as to the composition uncertain.

| $P_2O_5$ | $SO_3$ | FeO, MnO | CaO | Cl | F |
|---|---|---|---|---|---|
| 36·42 | 1·31 | 8·80 | 45·17 | 2·92 | *undet.*=97·93 |

Tetragophosphite is a mineral of a blue color resembling lazulite; it occurs in four-sided tabular crystals. One of two analyses gave:

| $P_2O_5$ | $Al_2O_3$ | FeO, MnO | CaO, MgO | $H_2O$ |
|---|---|---|---|---|
| 36·92 | 40·00 | 9·51 | 7·50 | 5·96 = 100 |

—*Zeitschr. Kryst.*, XXV, 444, 1895.

BLIABERGSITE and RANSÄTITE are two other names given by the above author to minerals from the Bliaberg in the Ransät parish, Wermland, Sweden; they occur associated with damourite. Bliabergsite occurs in small hexagonal crystals of a reddish color; hardness 4·5. An analysis gave:

| $SiO_2$ | $Al_2O_3$ | FeO | MnO | MgO, CaO | $H_2O$ |
|---|---|---|---|---|---|
| 39·13 | 27·60 | 26·74 | 4·45 | 0·43 | 3·26=101·61 |

*Ransätite* occurs in hard red spherules in damourite. Analysis gave:

| $SiO_2$ | $Al_2O_3$ | $Fe_2O_3$ | MnO | CaO | MgO |
|---|---|---|---|---|---|
| 43·47 | 14·50 | 17·72 | 14·97 | 5·63 | 2·57=98·86 |

—*Geol. För. Förhandl.*, xviii, 41, 1896.

8. *A mineralogical Lexicon of Franklin, Hampshire and Hampden Counties, Massachusetts*, by BEN K. EMERSON. Bulletin of the U. S. Geological Survey, No. 126. 180 pp. Washington, 1895.—This bulletin gives a full list of the minerals occurring in the three counties named, with historical notes, brief descriptions of species and occasional descriptions of crystals, new analyses, etc. The account of the remarkable crystals of stolzite and wulfenite from Loudville is especially to be noted.

9. *Recent works on Crystallography.*—The following works in this department have been received recently:

"Grundriss der Krystallographie für Studirende und zum Selbstunterricht," von Dr. GOTTLOB LINCK. 252 pages. Jena, 1896. (Gustav Fischer.)—This is an elementary work, embracing not only crystallography proper but also physical mineralogy. It has been prepared for beginners and those who may not have the advantages of a teacher, and hence is limited to the more elementary parts of the subject. These are well presented and fully illustrated.

"Lecture Notes on Crystallography," by HORACE B. PATTON. —This is a brief work (34 pp.) intended to be used in connection with lectures and practical exercises. It is clear and simple in

style and systematic in method and is likely to prove useful to students.

"Calcolo cristallografico:" Appendice al Trattato di Mineralogia, volume I, di Ruggero Panebianco, 48 pp. with 3 plates. —This appendix gives methods of calculation, formulas employed and practical illustrations of their use.

"Éléments de Cristallographie," 2me partie, Description de systèmes cristallines, par G. DEWALQUE. 103 pp. with 174 figures in the text. Liège.—A concise description of the different crystalline systems with the types of forms belonging to each.

## III. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *American Association for the Advancement of Science.*— The forty-fifth meeting of the American Association was held at Buffalo, N. Y., from August 24 to 29. The President of the meeting was Professor Edward D. Cope of Philadelphia. It is interesting to note that the Association has met three times previously in the same city, the last time in 1886. The present gathering was small, in fact one of the smallest in recent years, but in some respects the meeting was regarded as one of more than usual interest. One of the notable events was the delivering of the address by the retiring President, Prof. E. W. Morley of Cleveland, upon the subject "A completed chapter in the history of the atomic theory." Addresses were also delivered by the Vice-Presidents of the several sections. A commemorative meeting was held on Wednesday, August 26, in recognition of the geological work of Professor James Hall, extending over a period of sixty years. Special business transacted included a resolution favoring the introduction of the metric system, another opposing legislation against vivisection; a report from the committee on electrical standards, etc. The future policy of the Association, particularly as regards its relations to affiliated societies, was considered by the Council, but no conclusion was announced.

The city of Detroit was selected for the next meeting in 1897, and Dr. Wolcott Gibbs of Newport was chosen President. The Vice-Presidents elected to the several sections are as follows: *Section A*, W. W. Beman, of Ann Arbor, Mich.; *Section B*, Carl Barus, of Providence, R. I.; *Section C*, W. P. Mason, of Troy, N. Y.; *Section D*, John Galbraith, of Toronto, Canada; *Section E*, I. C. White, of Morgantown, W. Va.; *Section F*, G. Brown Goode, of Washington, D. C.;* *Section G*, George F. Atkinson, of Ithaca, N. Y.; *Section H*, W. J. McGee, of Washington, D. C.; *Section I*, Richard T. Colburn, of Elizabeth, N. J.

The following are the titles of papers accepted for reading:

SECTION A. *Mathematics and Astronomy.*

JAMES MCMAHON: A proposed fundamental integral-transcendent.
EDWIN B. FROST: On the level of sun-spots.
JAMES B. SHAW: Sedonians.

* Dr. Goode died on the 6th of September.

J. R. EASTMAN: Determination of weights of observation.

L. A. BAUER: On the distribution and the secular variation of terrestrial magnetism. No. IV. On the component fields of the earth's magnetism.

A. MACFARLANE: On the composition of simultaneous and successive vectors.

SECTION B. *Physics.*

F. E. MILLIS: An experimental study of the charging and discharging of condensers.

W. LECONTE STEVENS: Notes on certain physical difficulties in the construction of modern large guns.

ERNEST MERRITT: On the photographic trace of the curves described by the gyroscopic pendulum. On the distribution of high frequency alternating currents throughout the cross-section of a wire.

E. R. VON NARDROFF: On the compactness of a beam of light.

W. S. FRANKLIN: Some points in the mechanical conception of the electromagnetic field.

BROWN AYRES: Mechanical models of the electric circuit.

HENRY T. EDDY: Graphical treatment of alternating currents in branching circuits.

FREDERICK BEDELL and JAMES E. BOYD: Note on the effect of odd harmonics upon the virtual values of periodical varying quantities.

ALEXANDER MACFARLANE: On the rule for the dynamo and motor.

W. A. ROGERS: Description and exhibition of a convenient form of the "Interferential Comparer," and of an interferential caliper attachment for use in physical laboratories. Description and exhibition of a bench comparator for general use in physical laboratories. Experimental determination of the relative amounts of work done in changing the lengths of two metal bars under the same thermal conditions, by an envelope of heated air, and by pure radiations in a vacuum. An experimental method of finding the value of a unit of force in any system whatever.

EDWARD B. ROSA: A new alternating-current curve-tracer.

B. E. MOORE: Visible electric waves.

A. D. COLE: Electric waves in long parallel wires.

EDWARD L. NICHOLS and JOHN ANSON CLARK: The influence of a static charge of electricity on the surface tension of water.

W. S. FRANKLIN and L. B. SPINNEY: Determination of the specific heats of nitrogen by adiabatic expansion.

L. B. SPINNEY: The analysis of vowel-sounds, by means of the sympathetic vibrations of a rigid body.

C. P. HART: Polar and interpolar effects of the galvanic current on living animal tissues.

H. J. HOTCHKISS: Description and exhibition of a portable apparatus for recording curves of alternating currents and electro-motive force.

SECTION C. *Chemistry.*

T. H. NORTON: Points in teaching technical chemistry. On some new forms of gas generators.

G. C. CALDWELL: The aim of qualitative analysis.

H. P. TALBOTT: The aim and methods of the college course in qualitative analysis.

A. L. GREEN: The teaching of qualitative analysis.

F. P. VENABLE: The use of the periodic law in teaching general chemistry.

W. P. MASON: Chemistry at the Rensselaer Polytechnic Institute.

P. C. FREER: Laboratory instruction in organic chemistry.

A. A. NOYES: Laboratory instruction in organic chemistry. The teaching of physical chemistry.

ELLEN H. RICHARDS: Instruction in sanitary chemistry at the Mass. Institute of Technology.

J. L. HOWE and P. S. MERTINS: Notes on Reinsch's test for arsenic and antimony.

E. D. CAMPBELL: The limits of accuracy in analytical work.

ELLEN H. RICHARDS: Some points in the use of depths of color as a measure of chemical contents. The action of organic acids upon the mineral constituents of soils, or some compounds of iron with organic acids. Corrosion of metals by water. The meaning of the term "oxygen consumed" in the report of a water analysis.

ERWIN E. EWELL: A new form of laboratory condenser. A method of manipulation for the colorimetric determination of ammoniacal nitrous and nitric nitrogen in bacterial culture.

F. C. PHILLIPS: A new method for the determination of sulphur in white iron.

E. A. DE SCHWEINITZ: The necessity of animal experimentation in the study of bio-chemistry.

V. K. CHESTNUT: Andromedotoxin, the poisonous constituent of the Ericaceae and its relation to some food products.

LOUIS KAHLENBERG and R. H. TRUE: The toxic action of dissolved salts and their electrolytic dissociation.

W. P. MASON: Well water.

E. A. DE SCHWEINITZ: Value and use of formaldehyde as a disinfectant.

L. W. ANDREWS: Should the practice of embalming the dead be restricted by law?

E. G. SMITH: Observations on the sanitary nature of the Mississippi river water at different seasons.

H. W. WILEY: A modified form of the ebullioscope.

C. B. DUDLEY: Some applications of chemistry to railroads.

A. R. LEEDS: Recent developments in the purification and filtration of water.

C. PHILLIPS: Some properties and uses of natural gas. A new method for the determination of sulphur in white iron.

KARL LANGENBECK: The chemical problems of the pottery industry.

W. C. STUBBS: Sugar-making at the present day.

H. H. NICHOLSON: Some by-products of the sugar industry.

C. F. MABERY: Composition of American petroleum.

H. A. WEBER: Use of coal tar colors in foods.

E. W. HILGARD: Some points in the composition of California wines.

ERWIN E. EWELL: The alkaloids of *Anhelonium lewinii* (Mescal buttons).

L. L. VAN SLYKE: The work of the agricultural chemists of America.

S. M. BABCOCK and H. L. RUSSELL: Conditions affecting the normal viscosity of milk. On the restoration of the viscosity of Pasteurized milk and cream.

S. M. BABCOCK: A method of measuring the ripening of cheese.

SECTION D. *Mechanical Science and Engineering.*

WM. A. ROGERS: On the conversion of an ordinary planer into an apparatus for precise graduations.

J. H. KINEALY: The friction of the water in the pipes of a hot water heating system.

D. S. JACOBUS: Apparatus for exhibiting the distribution of moisture in a steam main. Values of heat of combustion of various gases per cubic foot for use in calculating the heating power from the analysis of a gas.

MALVERD A. HOWE: A new testing machine for beams and framed structures (capacity 50 tons).

THOMAS GRAY: On the yield point of steel.

W. S. ALDRICH: National endowment of engineering research.

R. H. RICHARDS: The cycle of the plunger-jig.

J. B. JOHNSON: Some results of the United States timber tests.

OLIN H. LANDRETH: Irrigation for the Eastern United States.

O. CHANUTE: Soaring flight.

M. E. COOLEY: The performance of small steam pumps.

SECTION E. *Geology and Geography.*

F. K. MIXER: The discovery of a new fish fauna, from the Devonian rocks of Western New York.

WARREN UPHAM: The Cuyahoga preglacial gorge in Cleveland, Ohio.

JAMES HALL: The operations of the Geological Survey of the State of New York.

J. E. TODD: A revision of the moraines of Minnesota.

THOMAS H. MACBRIDE: Notes on certain fossil plants from the Carboniferous of Iowa.

I. C. WHITE: Origin of the high terrace deposits of the Monongahela River.

HORACE C. HOVEY: The making of Mammoth Cave. The colossal cavern.

CHARLES R. EASTMAN: Observations on the dorsal shields in the Dinichthyids.

GILBERT D. HARRIS: The Eocene stages of Georgia.

G. P. GRIMSLEY: The origin and age of the gypsum deposits of Kansas.

J. W. SPENCER: Geomorphic notes on Norway.

LEA MCI. LUQUER and HEINRICH RIES: The "Augen-Gneiss," pegmatite veins, and diorite dikes at Bedford, Westchester Co., N. Y.

W. J. MCGEE: Sheetflood erosion.

ALBERT P. BRIGHAM: Glacial flood deposits in the Chenango valley.

T. C. HOPKINS: Origin of conglomerates.

COLLIER COBB: Origin of topographic features in North Carolina.

ARTHUR HOLLICK: The Cretaceous clay marl exposure at Cliffwood, N. J.

F. P. GULLIVER: Post-Cretaceous grade-plains in Southern New England.

E. H. WILLIAMS: Notes on Kansan drift in Pennsylvania.

H. B. BASHORE: Preliminary notes on the Columbian deposits of the Susquehanna.

G. K. GILBERT: The Algonquin River. The Whirlpool-Saint Davids channel. Profile of the bed of the Niagara in its gorge.

GEORGE W. HOLLEY: The Niagara Falls gorge.

WARREN UPHAM: Origin and age of the Laurentian Lakes and of Niagara Falls.

F. B. TAYLOR: Correlation of Warren beaches with moraines and outlets in southeastern Michigan. Notes on the glacial succession in eastern Michigan.

W. J. MCGEE: James Hall, founder of American stratigraphic geology.

JOHN M. CLARKE: James Hall and the survey of the fourth district.

SECTION F. *Zoology.*

EDWARD D. COPE: The bone-fissure at Port Kennedy, Pennsylvania.

C. W. HARGITT: Notes upon Cordylophora.

SUSANNA P. GAGE: Modification of the brain during growth.

B. F. KINGSBURY: Structure and morphology of the oblongata of fishes. A note on the membranous roof of the prosencephal and diencephal of Ganoids.

WILLIAM ORR, JR.: Differentiation of work in zoology in secondary schools.

JAMES G. NEEDHAM: Field work and its utility.

AGNES M. CLAPOOLE: Appendages of an insect embryo.

C. W. HARGITT: Experiments upon regeneration and heteromorphosis.

E. D. COPE: The penial structures of the saurians.

ISABELLA M GREEN: The peritoneal epithelium in amphibia.

GRANT S. HOPKINS: The heart of the lungless salamanders of Cayuga Lake.

GEO V. REICHEL: Observation on the chameleon, *Anolis principalis.*

MANLY MILES: Energy in animal nutrition. Relative efficiency of animals as machines.

C. W. HARGITT: Some abnormal chick embryos.

EDWARD L. RICE: On a peculiar fusion of the gill-filaments in certain lamellibranchs

THEODORE GILL: The relationships of the North American faunæ.

SECTION G. *Botany.*

W. W. ROWLEE: The development of the vascular elements in Indian corn. The stigma and pollen of Arisæma.

J. M. COULTER: Some remarks on chalazogamy. Embryo-sac structures.

L. M. UNDERWOOD: The habits of the rarer ferns of Alabama. Notes on the allies of the sessile Trillium.

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MARY A. NICHOLS: Studies in nuclear phenomena, and the development of the ascospores in certain Pyrenomycetes.

H. BAILEY: Remarks on the northern species of Vitis.

ALEX. P. ANDERSON: On the formation and distribution of abnormal resin ducts in Conifers.

ARMA A. SMITH: The development of the cystocarp of Griffithsia bornetiana.

C. L. POLLARD: On an apparently undescribed Cassia from Mississippi.

B. M. DUGGAR: A bacterial disease of the squash bug (Anasa tristis).

C. R. BARNES: What is the bark?

N. L. BRITTON: Some Cyperaceæ new to North America, with remarks on other species. On the Cardamines of the C. hirsuta group. Notes on the genus Amelanchier.

L. H. PAMMEL: Grasses of Iowa.

W. A. KELLERMAN: Ceres-Pulver, Jensen's new fungicide for the treatment of smut.

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ELIAS J. DURAND: Notes on the family Pezizaceæ of Schröter.

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HERMANN VON SCHRENK: Some adaptation of shore plants to respiration.

D. T. MACDOUGAL: Reaction of leaves to continual rainfall. Influence of rainfall upon leaf forms. The mechanism of curvature in tendrils.

SECTION H. *Anthropology.*

HORATIO HALE: Indian wampum records.

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DANIEL G. BRINTON: Resolution upon the appointment of a committee to report on "The Ethnography of the White Race in the United States." The psychic source of myths.

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W. W. TOOKER: Meaning of the name Manhattan.

A. F. CHAMBERLAIN: Kootenay Indian place names. Kootenay Indian names of implements and instruments.

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J. MCKEEN CATTELL: Physical and mental measurements of students of Columbia University.

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GATES P. THURSTON: Shell gorgets and ceremonial implements. A ceremonial flint implement and its use among the ancient tribes of Tennessee.

DAVIL P. BARROWS: Some Indian rock and body painting in Southern California.

F. W. PUTNAM: Recent explorations in Honduras by the Peabody Museum.

HENRY C. MERCER: Result of recent cave exploration in the Eastern United States.

H. W. SMITH: Finland vapor baths.

FRANZ BOAS: Cupped stones.

F. W. HODGE: Pueblo Indian clans.

JAMES MOONEY: Mescal plant and rite.

SECTION I. *Social and Economic Science.*

JAMES A. SKILTON: The proposed sociological institution.
AARON B. KEELER: The value of social settlement.
MARY J. EASTMAN: Human reciprocity.
JOHN A. MILLER: Better distribution of forecasts.
A. P. WINSTON: The tin plate experiment.
W. LANE O'NEILL: Suicide legislation.
EDWARD ATKINSON: Crime against labor.
S. F. KNEELAND: Practical studies in horticulture, art and music. Relics of ancient barbarism.

## OBITUARY.

JOSIAH DWIGHT WHITNEY, one of the pioneers among American geologists, died on August 19th aged seventy-six years.

He was born in Northampton, Mass., November 23d, 1819, was graduated at Yale in 1839 and began his active geological work as assistant geologist under Charles T. Jackson on the survey of New Hampshire in 1840, where he was engaged for two years. In 1847 he, with J. W. Foster, was appointed by the United States government to assist Jackson in the geological exploration of the Lake Superior region. After two years this work was committed to Foster and Whitney alone, and the results of their labors were published in 1849, 1850 and 1851 in "Synopsis of the explorations of the Geological Corps in the Lake Superior Land District in the Northern Peninsula" (Washington, 1849), and the "Report on the Geology and Topography of a portion of the Lake Superior Land District in the State of Michigan" (Part I, Copper Lands, 1850; Part II, The Iron Region, 1851).

In 1855 he began geological work in Iowa, associated with James Hall; the results of this survey were published as "Reports on the Geological Survey of Iowa" (2 vols., Albany, 1858–9); the geological part being contributed by Whitney, James Hall furnishing the paleontological volume. Next Professor Whitney undertook the investigation of the lead region in Wisconsin and adjoining territory, the account of which was published in the "Report on the Geological Survey of the State of Wisconsin" (Albany, 1862). In this survey James Hall was also associated with him as paleontologist.

In 1860, at the close of the survey in Wisconsin, Professor Whitney was appointed State Geologist of California. Here he organized and carried out a thorough survey of the topographical, geological and natural history features of the state, and published the results in a series of six volumes entitled "Geological Survey of California" (Cambridge, 1864–70), besides annual reports and papers in the scientific journals, giving accounts of the progress of the survey. This was his most elaborate work and that in which his best powers were shown. During the execution of these local geological surveys he published several works of a more general nature. An English translation of Berzelius's "Use of the Blowpipe" was published in 1845. In 1854 appeared "The Metallic Wealth of the United States

described and compared with that of other countries," the result of extensive travel investigating the mines and mineral regions east of the Mississippi. In 1869 "The Yosemite Guide-Book" was published.

In connection with his investigations in Iowa he held the position of State Chemist and Professor in the Iowa State University for several years from 1855. In 1865 he was appointed Professor of Geology, with charge of the School of Mining and Practical Geology, which position he held at the time of his death. During the year 1869 he took a party of students (Marvine, Gannett, Bridge, and Davis) who were taking the mining course at Harvard, to Colorado, where the summer was spent in exploring and surveying. It was on this expedition that the heights of a number of important peaks back of the Front Range were first correctly determined: among these were Mts. Harvard and Yale, to which these names were then given.

He was fond of books and lavished much expense both in accumulating and binding them. By arrangement with the Faculty of the Museum of Comparative Zoology, Whitney's library of geological works goes to the Museum: it is rich in state and national surveys in the United States, and in statistics and journals on mining in all parts of the world. During the last twenty years of his life his lectures were chiefly on economical geology, but he gave occasional courses on dynamical geology, on the physical geography of the United States, and on the history of geographic discovery.

The death of his wife in Cambridge and his daughter (Mrs. T. Allen) in Paris on the same day (about 15 years ago) was a terrible blow, causing him to withdraw into himself, increasing the isolation of his later years.

He was a man of very positive convictions; retaining views of earlier years little changed by later work, and hence increasingly out of sympathy with various theories of modern geology. He had great linguistic ability, like his brother, William D. Whitney. When about 60, he acquired a good knowledge of Russian, and read not only geological and geographical reports, but modern Russian novels in the original. Prof. Whitney had a remarkable knowledge of music, and accumulated an extensive collection of musical works including orchestral scores of classic compositions. He was a familiar figure at the symphony concerts in Boston and Cambridge with score open before him. A great reader, busy worker, active and alert, until last winter when his health seriously failed. He was an original member of the National Academy of Science, and a member of numerous other scientific societies. The degree of LL.D. was conferred on him by Yale in 1870. Mt. Whitney, in southeastern California, the highest mountain in the United States, outside Alaska, was named in his honor.

George Brown Goode died in Washington on the 6th day of September. Born in New Albany, Ind., Feb. 13th, 1851, he

was early interested in natural history studies, graduated at Wesleyan in 1870, and in the following year took charge of the college museum. His chief scientific work was in ichthyology, and he published numerous works on fish and fisheries. He began his official connection with the Smithsonian Institution in 1873, and from 1874 to 1887 held the office of chief of the division of fisheries. He was U. S. commissioner to the international fishery exhibitions in 1880 at Berlin and in 1883 at London. In the Halifax fisheries commission he was the statistical expert employed by the government, and in 1879–80 he had charge of the fisheries division of the 10th census. In 1877 Mr. Goode was appointed a curator, and in 1881 assistant director, of the National Museum, and in 1888 he became assistant secretary of the Smithsonian Institution, which position he held at the time of his death.

It was in the administration of the internal affairs of the Smithsonian Institution that his great ability and tact as an organizer and executive were displayed. He made himself acquainted with every detail of the complex museum, and was able to speak with authority in such publications as "Plan of Classification for the World's Columbian Exposition" and "Museums of the Future." In his relations with his fellow-workers in science Mr. Goode was liberal in extending both assistance and encouragement to scientific progress, and his loss will be deeply felt by those engaged in the promotion of science both at home and abroad. His publications were numerous, especially in the department of Ichthyology. His latest work (Ocean Ichthyology, a treatise on the deep-sea and pelagic fishes of the world, based chiefly upon the collections made by the steamers Blake, Albatross, and Fish Hawk in the Northwestern Atlantic, with an atlas containing 417 figures. 2 vols. Text, pp. 557. Plates, 122. Washington, 1895), published in coöperation with Dr. T. H. Beam, was issued only a short time before his death, and will stand as a lasting memorial of his energy and skill as a naturalist. He was a member of the National Academy of Sciences and of numerous other scientific bodies.

Sir William Robert Grove died in August last at the advanced age of eighty-five. Though belonging to the legal profession and having devoted a large part of his life to the law, his contributions to physical science, more especially from 1835 to 1866, were of great value. The "Grove cell" and "the Grove gas battery" are familiar to all workers in physics. His essay on "The Correlation of Physical Forces," which appeared in 1846, has been spoken of as "the first systematic statement of the connections between the different departments of physical phenomena." This essay and that of Helmholtz, of the following year, "may be said to form the starting point of the modern science of energetics, of which the experimental foundation was even then being overhauled and laid still more deeply and stably by Joule."

Dr. August Kekulé, Professor of Chemistry at the University of Bonn, died on July 13 at the age of sixty-six years.

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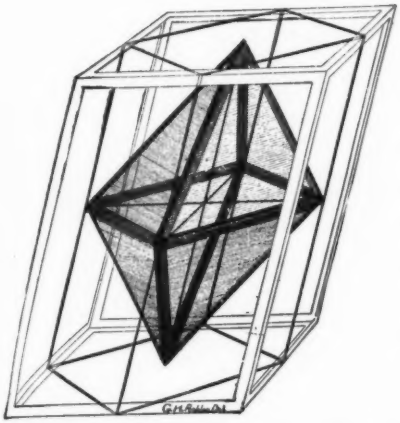

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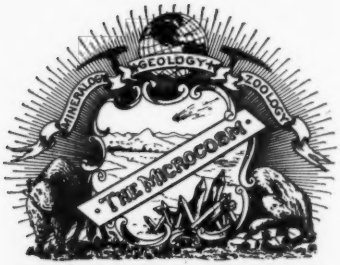


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(1) Described in this Journal Sept., 1895. (2) Ibid Nov., 1887. (3) Proc. Roch. Acad. Sci., Vol. 1. (4) This Journal Aug., 1888. (5) Ibid July, 1893. (6) Ibid June, 1894.

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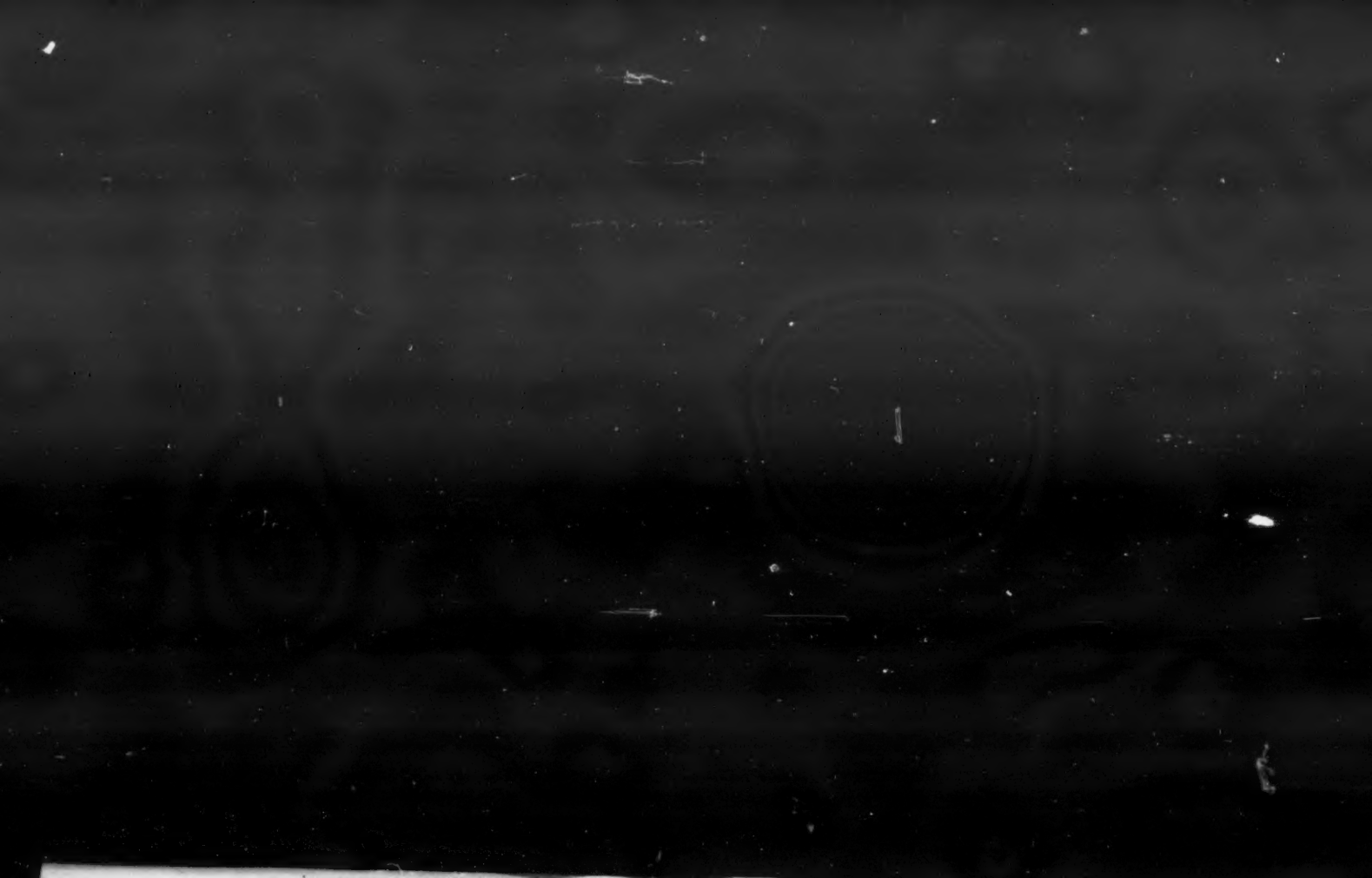
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